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THE WORLD IS ITS FIELD

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THE UNITED STATES NATIONAL BUREAU OF STANDARDS.

By Herbert T. Wade.

In a following article, Mr. Emerson calls attention to the surprising neglect of the Congress of the United States to establish legal standards of weights and measures. It is therefore of especial interest to study, through Mr. Wade's review, the practical results accomplished by the director and officers of the Bureau of Standards in securing standards, enabling comparisons, determining constants, and co-operating with manufacturers to establish substantial and proper uniformity throughout the States.—THE EDITORS.

BY the Constitution of the United States the power to fix the standard of weights and measures is expressly and specifically conferred upon Congress, but this power has seldom been exercised by that body and the present condition of American weights and measures is more the result of a natural and unrestricted development and evolution than of any legislative policy of the Government. Although the subject of weights and measures has received so little attention from Congress, yet a great deal has been accomplished by the executive branches of the Government towards securing a practical and proper uniformity. In fact this was most essential under the Constitution which provides that taxation shall be uniform throughout the nation. Now since a large part of the national revenue is raised by internal revenue or customs taxes levied specifically on quantities of commodities, not only the necessity of complying with this provision of the Constitution but justice and equity demand that the Government everywhere should use uniform and correct weights and measures. This of course can be accomplished only by having certain definite and concrete standards duly recognized by statute, to which all other weights can be

referred, and by providing proper facilities for their construction, custody, and comparison with other standards.

In the United States the National Bureau of Standards is responsible for thus securing uniformity of weights and measures, and for certain other scientific duties, mainly those in which measurement is the prime consideration. As this bureau was founded only in 1901 it will be of interest to trace briefly the development of the work which finally called for its establishment. In the early days of the republic there was no particular uniformity of weights and measures, and most of the States which had standards employed those legalized in the colonial days and derived in the main from the standards of the Exchequer in London. Aside from revenue and commercial considerations the National Government realized this lack of uniformity and harmony in the various standards of length when the Coast Survey was established in 1815. Now as one of the first essentials of a survey is the accurate measurement of linear distances, it was necessary at the outset to obtain standards not only for use in the actual measurement, but from which other standards could be made and to which all measurements could be referred. The standard selected for this purpose, strange as it may seem, was a metre bar which had been constructed by the first International Metric Committee, and this standard was employed by the United States Coast and Geodetic Survey until the new National Prototype Metre was substituted as a standard on its receipt from the International Bureau of Weights and Measures in 1890. In addition to the metre an 82-inch bronze bar was secured from London as a standard of length for the customary measures, and these two bars, originally in the custody of the Coast Survey, mark the beginning of standards of length in the United States. The Coast Survey, it should be noted, was then under the Department of the Treasury, which on account of its collection of customs and internal revenue taxes was the branch of the Government most concerned with weights and measures.

As regards weights and measures of capacity the conditions were even more unsatisfactory than with the standards of length, and realizing the lack of uniformity at the various ports and collection districts, the Department called in for examination the various standards in use and found a surprising absence of harmony. It was ascertained that State, county, and town standards were used indiscriminately and in many cases substantial losses to the Government were involved. As a result of these revelations steps were taken to construct secondary standards, the duty becoming a recognized part

of the work of the Coast Survey, whose superintendent for many years was usually head of the Office of Weights and Measures. Suitable standards of length and weight for the custom houses were provided, and later Congress decided that standards and balances of precision should be made by the Survey and sent to the various States and territorities. These in most cases by act of legislature became legal standards from which county, city or town standards were derived, and in this way the weights and measures of the United States gradually became assimilated to a common standard.

Little by little the work of the Office of Weights and Measures developed, until in addition to safeguarding the standards of the nation and making such tests and verifications as were required by the various branches of the Government, there came demands for comparisons with the national standards not only from makers of weights and measures, but from manufacturers of machinery, tools, and gauges, especially where standardization and interchangeability were essential. Then again there was the construction of standard sets of metric weights and measures which Congress when it legalized the metric system (July 28, 1866) provided should be distributed to the various States and territories. Mechanical work of the War and Navy Departments often involved reference to standards of weight and length, while the base bars and tapes used by the Coast and Geological Surveys stood in constant need of graduation or verification. Then when it became necessary for the Government to assume control of electrical standards, the determination and care of these were included in the duties of the Coast and Geodetic Survey. Furthermore it was recognized that there was other fundamental scientific work that properly could be done by the general Government, involving as it did careful physical or chemical investigation in connection with standards of measurement. Moreover it was realized that the greatest practical benefit to manufacturing, and industrial trades and commerce had resulted from such government scientific bureaus in Europe, especially in the case of the Normal Eichungs Kommission and the Kaiserliche Physicalisch-Technische Reichsanstalt in Germany. Accordingly with the approval of scientific, engineering, and manufacturing interests by Act of Congress approved March 3, 1901, the National Bureau of Standards was established under the jurisdiction of the Treasury Department.

In order that there should be no opportunity for future misunderstanding or any curtailment of the efficiency of the new bureau, care was taken to define its functions with considerable precision, yet

THE MECHANICAL LABORATORY AND POWER PLANT (ABOVE) AND THE PHYSICAL LABORATORY, NATIONAL BUREAU OF STANDARDS.

at the same time to permit a wide range of activities. These functions are in substance as follows: the custody of the standards; the comparison of the standards used in scientific investigations engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction, when necessary, of standards, their multiples and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants and the properties of materials, when such material data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere. The Act further provided that the bureau should exercise such functions not only for the National Government, but also for the various State and municipal governments, and for institutions, societies, corporations and individuals according to proper regulations and, except in the case of the United States or State governments, on payment of reasonable fees. Likewise provision was made for a suitable scientific staff whose salaries were made sufficient to attract competent scientists to the establishment, while an appropriation was made for the purchase of ground and the erection of buildings.

Professor S. W. Stratton of the University of Chicago was appointed as the first director of the Bureau of Standards, and the organization of its work was commenced immediately under his direction. The standards and apparatus of the Office of Standard Weights and Measures were turned over to the new bureau, and the laboratories and other rooms in the Coast and Geodetic Survey Building were retained temporarily pending the erection of new buildings. By the Act of May 14, 1903, establishing the Department of Commerce and Labor, the Bureau of Standards was put under its jurisdiction but no change in organization or plan occurred. While considerable scientific work was accomplished at this time, yet it was in the main preparatory to the equipment of the new laboratories, as modern scientific work, especially that concerned with weights and measures, depends very largely upon apparatus and other facilities. The buildings were completed in 1904 and occupy a tract of about 7½ acres in a suburban neighborhood in the northwestern section of Washington, 3½ miles from the White House. The site occupies a high hill about 350 feet above the Potomac and is quite free from vibrations from street traffic or from the magnetic effects caused by electric railways, except for refined magnetic experiments which ordinarily would be performed in the Government magnetic observatories in rural regions far away from such disturbances.

The chief building of the group belonging to the Bureau of Standards is the physical laboratory containing the offices, library and laboratories for investigation and the testing of standards and measuring instruments. It faces the mechanical laboratory which includes also the instrument shop and power plant. Near the latter building is the low-temperature laboratory, while a new building for mechanical testing and investigation upon the properties of materials, for which Congress has appropriated $175,000, is to be erected to the west, forming the third side of a quadrangle. The physical laboratory is four stories in height with an attic, and is built of dark red brick and buff Bedford limestone, the latter material being used for the first

THE LOW-TEMPERATURE LABORATORY.

story and the trimming. The building faces to the south or towards the city of Washington, thus affording ample illumination and direct sunlight for the optical and other laboratories where it is essential. It is 172 feet in length by 55 feet in breadth and is connected with the power plant in the basement of the mechanical laboratory by an underground passage or tunnel through which pass all pipes, conductors, ventilating flues, etc. It is of course a prime requisite for such a building that it should be massive and stable in its construction in order to avoid vibration and that it should contain no large moving machinery; consequently all engines, dynamos, pumps and apparatus of this nature are located in the mechanical building, but direct connections are made through a complete system of pipes and wires

with all parts of the physical laboratory. Double windows protect the laboratories from outside temperatures and draughts and air currents, and an elaborate system of heating and ventilation controlled by automatic thermostats secures within suitable limits any desired degree of dryness or temperature. This is not only for the comfort of the investigators during a Washington summer, but also to enable certain experiments to be carried on independent of atmospheric conditions and to preserve from rust and deterioration many valuable instruments in use during the summer months. To provide a suitable and easily regulated temperature, hot air is used, as this saves valuable space that would be occupied by steam pipes, which also on account of their magnetic properties, varying both with time and temperature, often prove very annoying in refined electric and magnetic experiments. The hot-air system possesses the further advantage of allowing the air to be cooled in summer and the moisture to be removed as well, being then heated to any desired temperature so that the windows of the laboratories need never be raised. In addition the air thus supplied is first filtered and the amount of dust is kept at a minimum. As the air is constantly being drawn out and replenished there is no chance for the moisture produced by the respiration of the workers or by evaporation to remain.

The stability of the building enables the bracket tables or shelves attached to the structural walls to furnish a firm support for instruments, thus obviating the separately founded masonry piers extending through one or two stories which often act as inverted pendulums with periods of vibration of their own. There are, however, piers resting directly on the ground in the laboratories on the ground floor on which such instruments as the comparators and the precision balances and their telescopes can be mounted.

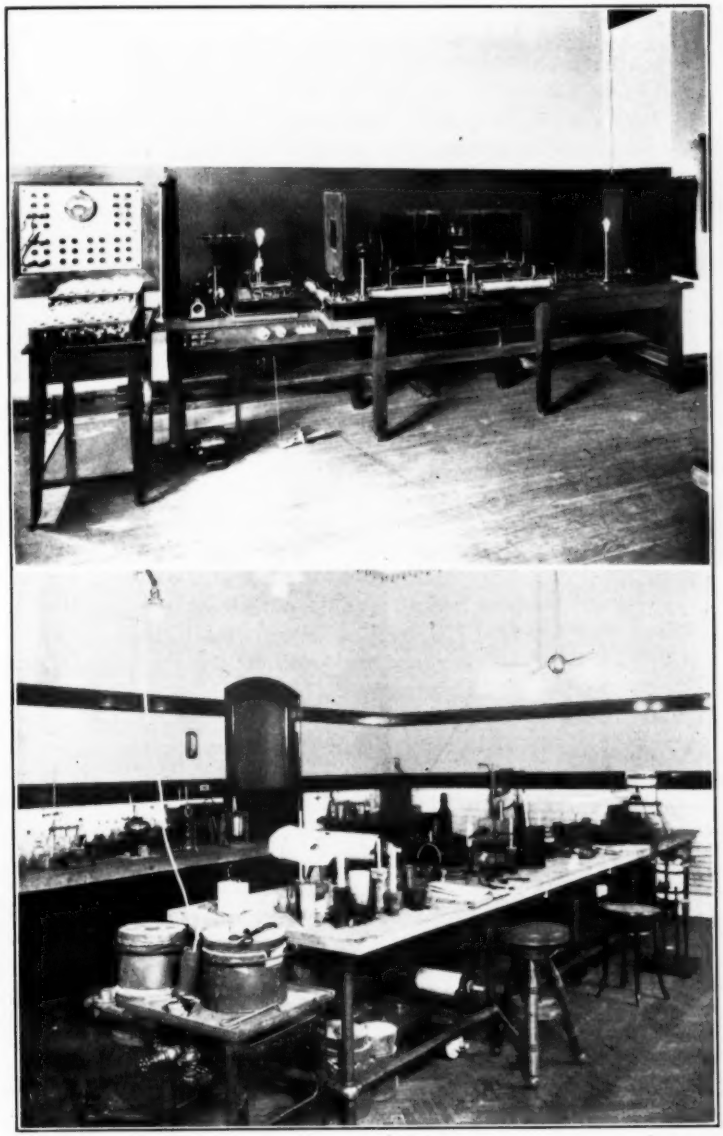
To supply the necessary electric current, gas, steam, compressed air, exhaust, ice water, distilled water, cooled brine, etc., all of which are produced in the power plant, pipes and conductors after passing through the connecting subway to the physical laboratory are led to four vertical shafts, one at each corner of that building, which in the main partition walls extend from cellar to roof. On each floor connections are made for the regular service, while for special purposes any temporary arrangement of piping or wiring desired in any of the special laboratories readily can be effected. There is a small switchboard for each set of two or three adjacent rooms so that current can be led direct to any particular work table, while the mains running through the building are all connected with a switchboard on the

ground floor from which trunk lines run to the main switchboard in the dynamo room. Thus any current, direct or alternating, of any potential or phase desired by an experimenter, can be furnished without disarranging any other circuits.

The scientific work of the Bureau is divided among a number of sections, each under the direction of a specialist. The arrangement while elastic indicates in a general way the range of activity of the Bureau. The sections are as follows: Electrical resistance and electromotive force; inductance, capacity and absolute measurements; electrical measuring instruments; magnetism; photometry; weights and measures; thermometry, pyrometry and heat measurements; spectroscopy; radiometry; polarimetry; chemistry; engineering instruments; and properties of materials.

The room of chief interest in the physical laboratory is the vault where are preserved the national standards of length and mass—the prototype metre and kilogramme—and various other standards and historic bars, weights, and measures. This room can be entered only through steel double doors, and though heavily walled is lighted by electricity and is ventilated for the reasons already mentioned. In addition to the national standards made under the direction of the International Commission of Weights and Measures, it contains such historic standards as the old "Committee metre" dating back to the founders of the metric system, the Troughton and Simms 82-inch scale, 36 inches on which furnished the first official yard for the United States, and the bronze copy of the imperial yard of Great Britain which served as a standard of length until the arrival of the standard metre and kilogramme from the International Bureau of Weights and Measures at Sèvres. In this vault it is believed that almost ideal conditions of temperature and dryness of the atmosphere are obtained, so that the standards remain at a constant temperature and are not exposed to changes which might act to alter their molecular arrangement and thus affect their absolute length.

For the most precise comparisons, such as would be involved in the verification of the secondary standards of the Bureau, the national standards can be removed to a special comparator now in course of construction in the instrument shop of the Bureau and designed to embody all the refinements of construction of which metrology and mechanical science are capable. Its striking and most original feature is a massive composite bar of invar, a form of nickel steel with a remarkably small temperature coefficient, on which the micrometer microscopes are to be mounted.



THE PHOTOMETER ROOM (ABOVE) AND THE LABORATORY FOR PYROMETRY.

Comparisons of geodetic bars, tapes, and longer standards of length are most effectively carried on in the special laboratory located in the tunnel connecting the physical laboratory with the power plant. This laboratory is formed by a longitudinal wall dividing this tunnel or passage, and in addition to containing permanent mountings for the instruments it has a system of brine and steam coils regulated by thermostats, so that any desired temperature between 0 and 40 degrees centigrade can be maintained. For testing and comparing the geodetic standard bars and tapes there are a series of pillars on independent foundations placed in line at distances of 5 metres, on which micrometer microscopes can be mounted so that by the use of a standard bar of 5 metres in length other bars and tapes can be standardized with great accuracy, the original bar being surrounded with shaved ice and supported in a movable carriage which is passed successively under each pair of micrometer microscopes. At one of the 5 metre intervals there are pillars spaced a metre apart on which microscopes can be similarly mounted and the 5-metre bar standardized directly from the national prototype. On one wall of the tunnel is mounted the 50-metre bench standard for the verification of ordinary steel tapes. This consists of a strip of cold-rolled steel which by the use of thermit has been welded into a continuous bar 50 metres in length; it is mounted perfectly horizontal and free to move on brackets and rollers. This strip of metal has been carefully standardized both for customary and metric measures.

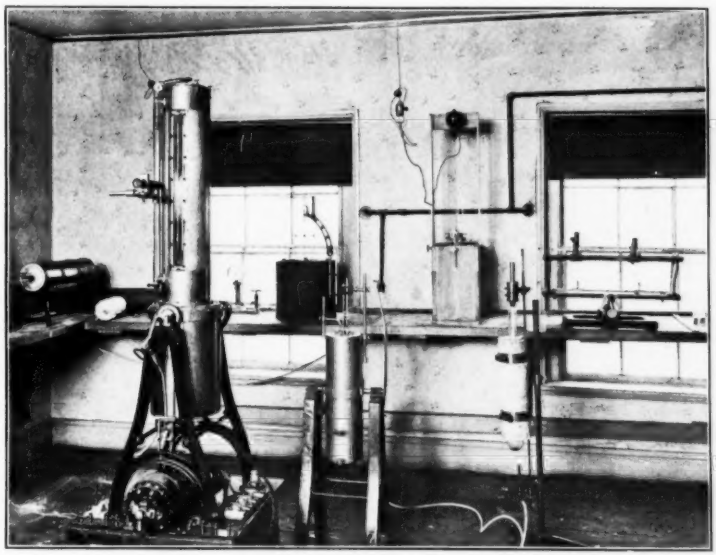
Here now are standardized the base bars and tapes of the United States Coast and Geodetic Survey, so that all its measurements can be reduced to a single standard with the highest possible precision. It was in this tunnel that the new invar tapes of the Coast Survey were recently studied and standardized. As these tapes have only 1-28 of the expansion of steel tapes, they are available for use without a temperature correction and consequently are far better suited for measuring base lines, especially as the measurements can be made in the day time and not at night as is essential in accurate work with ordinary steel tapes.

In rooms on the ground floor of the physical laboratory may be seen a considerable equipment of balances of precision, one of which is arranged for weighing in vacuo by connection with an exhaust. They are supplied with various devices enabling the observer to control their operation from a distance of about 12 feet, so that the heat of his body will have a minimum effect.

The principal duty of the Bureau as regards weights is to verify the secondary standards and the finer sets of weights made by manu-

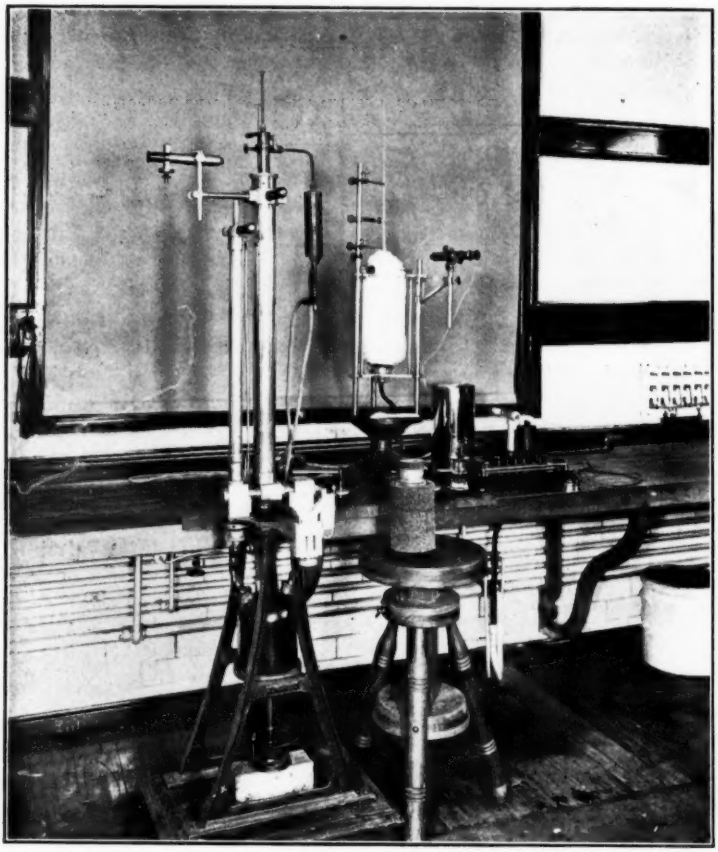
facturers, and to examine State and other legal standards. Lately the Bureau has endeavored to secure greater uniformity in weights and measures throughout the country at large by co-operating with and advising the State and local sealers and inspectors of weights and measures, and three conferences of such officials have been held at the Bureau.

The work with measures of length varies from the verification of test pieces and gauges used in mechanical engineering to the comparison and graduation of standard bars, as has been done for the Governments of Canada, Japan, Chile, and Mexico. Most of the test pieces or gauges used in shop testing are end standards and special apparatus has been devised in many cases to verify them, an exceedingly accurate instrument having been constructed at the Bureau to compare line with end standards.



APPARATUS FOR THE COMPARISON OF THERMOMETERS.

In thermometry, pyrometry, and high-temperature measurement the Bureau carries on work of great importance to both science and industry, especially as instruments for high-temperature measurements now figure in many important manufacturing processes. The temperature as given by the Bureau is defined by Baudin and Tonnelot primary-standard thermometers, standardized according to the international hydrogen scale adopted October 15, 1887, in which the



STEAM-POINT AND ICE-POINT APPARATUS FOR TESTING OF THERMOMETERS.

scale of temperature is defined by the expansion of a given volume of hydrogen between the temperatures of melting ice and boiling water. The Bureau tests mercurial thermometers of all descriptions that conform to its specifications, and in addition to determining the ice and boiling points, the thermometers not properly aged or annealed are placed in an electric heating apparatus where they are subjected to comparatively high temperatures. Electric heating is used throughout this department for regulating the temperatures of the various baths in which the thermometers are immersed and wherever any constant or desired temperature is needed. Tests are also made of special

high-temperature mercurial thermometers made of very hard borosilicate glass thoroughly annealed and capable of measuring temperatures up to 550 degrees centigrade and used for such industrial purposes as the determination of the temperature of various chemical reactions, galvanizing baths, hot blast, flue gases, etc. In these thermometers for reading above 275 degrees centigrade the space above the mercury is filled with some inert gas such as nitrogen or carbonic acid under a pressure of about twenty atmospheres, thus preventing the mercury from boiling as it would were the pressure normal.

The Bureau also standardizes platinum resistance thermometers which can measure from the lowest temperatures up to 1,000 degrees centigrade (1,800 degrees F.). As these instruments depend upon the measurement of the resistance of platinum at different temperatures, the experts of the Bureau test such thermometers by determining their resistance at the temperatures of melting ice, steam, and sulphur vapor, or if it is to be used for low temperatures at the temperature of boiling oxygen, and then constructing a table referring these resistances to temperatures on the scale of the standard gas thermometer. The Bureau also tests thermo-couples and issues certificates showing the correct readings at different temperatures, which for this instrument range from that of liquid air to 1,500 degrees centigrade. For the lower temperatures (600 degrees to liquid air) a couple of copper-constantan or iron-constantan is used, while for the higher portion of the scale a thermo-couple formed of pure platinum fused to an alloy of platinum with iridium or rhodium is used. These couples, which are first annealed at white heat, operate by using a galvanometer to measure the electromotive force produced when the two junctions of the couple are at different temperatures. Following the methods tested and recommended by the Bureau and observing suitable precautions, the thermo-couple affords an accurate and convenient means for measuring temperatures.

For the highest temperature measurements, even in industrial operations, optical pyrometers are employed, so it has been necessary for the Bureau to study these instruments carefully and it is now in a position to test and calibrate them. They have a range from 600 degrees centigrade to the highest attainable temperatures, such as that of the electric arc, and consist essentially of two kinds: those in which the temperature of the incandescent body is measured by the intensity of the light emitted by the body, and those in which the temperature is measured by the heat emitted by the body, which includes the energy of the visible light waves as well as that of the

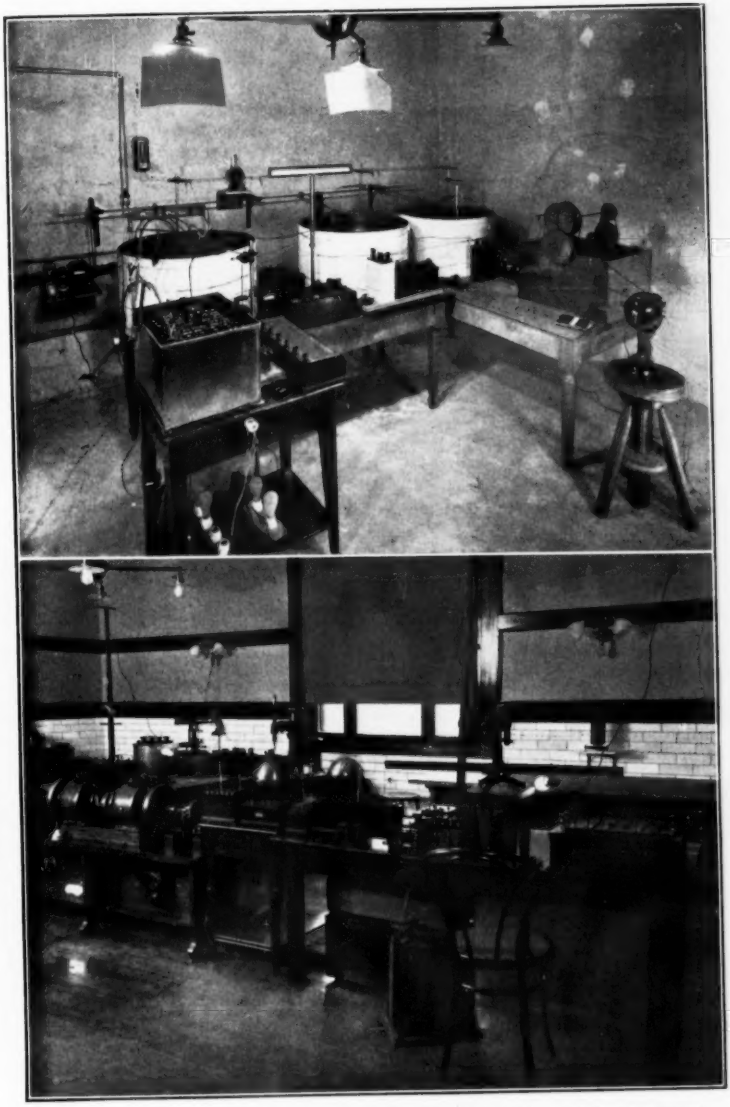
invisible heat waves. Optical pyrometers find application in determining the intensity of temperature in the hottest furnaces, and are beginning to be widely used in industrial work, as in measuring the hardening or annealing temperature of steels where a difference of 25 degrees centigrade in the hardening temperature is often sufficient to change entirely the properties of the steel. As a result of the pyrometer being better understood, and instruments that can be calibrated accurately being available, the old method of guessing at the proper temperature at which various industrial operations should be carried on has been largely abandoned, and the pyrometer or some similar instrument is employed. The Bureau now knows the relative accuracy and availability of the various types of pyrometers and is prepared to standardize such instruments for manufacturers.

It is for such standardizing among other purposes that the Bureau must determine the melting points of such metals as iron, tin, nickel, cobalt, palladium, platinum, etc., for the melting points of these metals serve as fixed points on the temperature scale, just as the melting point of ice and the boiling point of water serve as fixed points for thermometers at ordinary temperatures.

The Bureau has also done important work in determining the temperatures of the arc (3,700 degrees centigrade), and in studying the filaments of incandescent lamps in order to determine the cause of the efficiency of the new metal-filament lamps such as the tungsten and tantalum, over the carbon-filament lamp. It was found that the great gain in efficiency was to a great extent due to the higher temperature at which these lamps could be used.

The work of the heat section includes the determination of important thermal constants used in scientific and engineering work, as for example the specific heat of brine, a constant of great importance to refrigerating engineers. Such an investigation and re-determination is at present under way. Another important determination involves the heat value of a number of substances that can be used in the standardization of combustion calorimeters. Calorimeter tests are now being increasingly used to determine the heat value of coals, as this seems to be a most satisfactory basis for the purchase of such fuel, and has been adopted by some departments of the United States Government. The accurate thermometers of the Bureau also are used for testing oils for their flash points, a very important matter, as this quantity figures in many statutes

In the electrical laboratories standard and other resistances are checked and calibrated and standard cells are tested. Here, as in the



ABOVE, INSTALLATION FOR TESTING OF STANDARD CELLS; BELOW, ELECTRICAL LABORATORY.

National Physical Laboratory in England and the Physicalisch-Technische Reichsanstalt near Berlin, investigations have been conducted to determine the accuracy with which the Clark and Weston cells can be reproduced from specifications involving the mode of preparation and the purity of the materials employed.

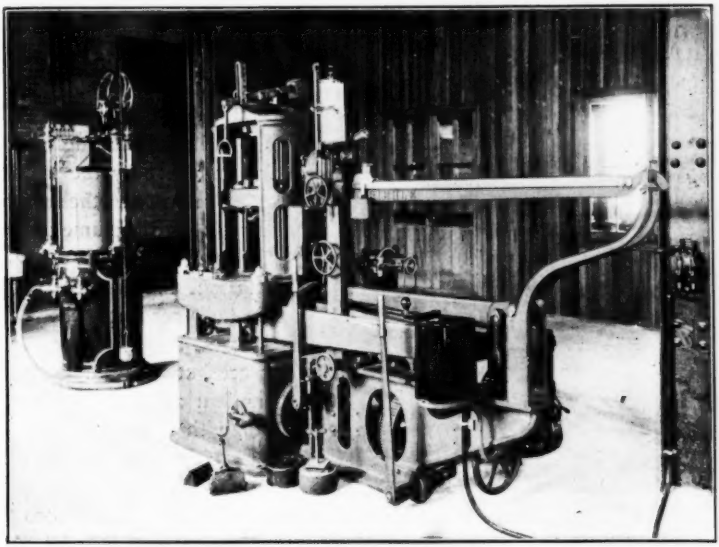
This work will have an important bearing in an international conference on electrical units which has been called to adopt definitions for the fundamental electrical units to be recommended for universal adoption.

Preliminary steps have been taken by the Bureau to construct a primary mercurial standard ohm, as by the definition of the electrical units all measurements are expressed in terms of a mercury column of resistance of specified length and cross section. Another important investigation in progress at the Bureau is the determination of the conductivity of copper, which has been requested by the standards committee of the American Institute of Electrical Engineers in order to re-determine the temperature coefficient and the specific conductivity. Both of these constants are most important in all electrical engineering, the former especially being used in determining the rating of electrical machinery. At the same time these constants for aluminum and other metals used in the electrical arts will be determined also.

The Bureau carries on important work in chemistry, which consists in the main in co-operating with the other branches in their investigations. In fact, this is characteristic of the entire work of the institution. The samples of standard irons formerly prepared and distributed by the American Foundrymen's Association are now issued by the Bureau of Standards to which this duty has been transferred. A similar arrangement has been completed with the American Steel Manufacturers' Association for the preparation of standard samples of steel of three types—bessemer, basic open-hearth, and acid open-hearth—and these have been analyzed and are ready for distribution.

In an independent building is housed the low-temperature laboratory which contains among other apparatus that for producing liquid air and hydrogen. Most of this apparatus was a part of the British exhibit at the St. Louis Exposition. It is of the same type as that used with such success by Professor Dewar at the Royal Institution in London. The outfit includes a two-stage air compressor for pressures up to 3,000 pounds; a single-stage carbon-dioxide compressor for auxiliary cooling; a hydrogen compressor of the two-stage type

working up to pressures of 3,000 pounds; also an apparatus for generating large quantities of pure hydrogen by the action of sulphuric acid on zinc; all manufactured by Lennox, Benton and Reynolds, of London. The Bureau has added a direct steam-driven, four-stage Norwalk compressor, capable of compressing 70 cubic feet of air per minute to 5,000 pounds pressure. The plant can supply the liquefied gases in substantial amounts for laboratory experiments.



RIEHLÉ TESTING MACHINE AND METER PROVER, MECHANICAL TESTING LABORATORY.

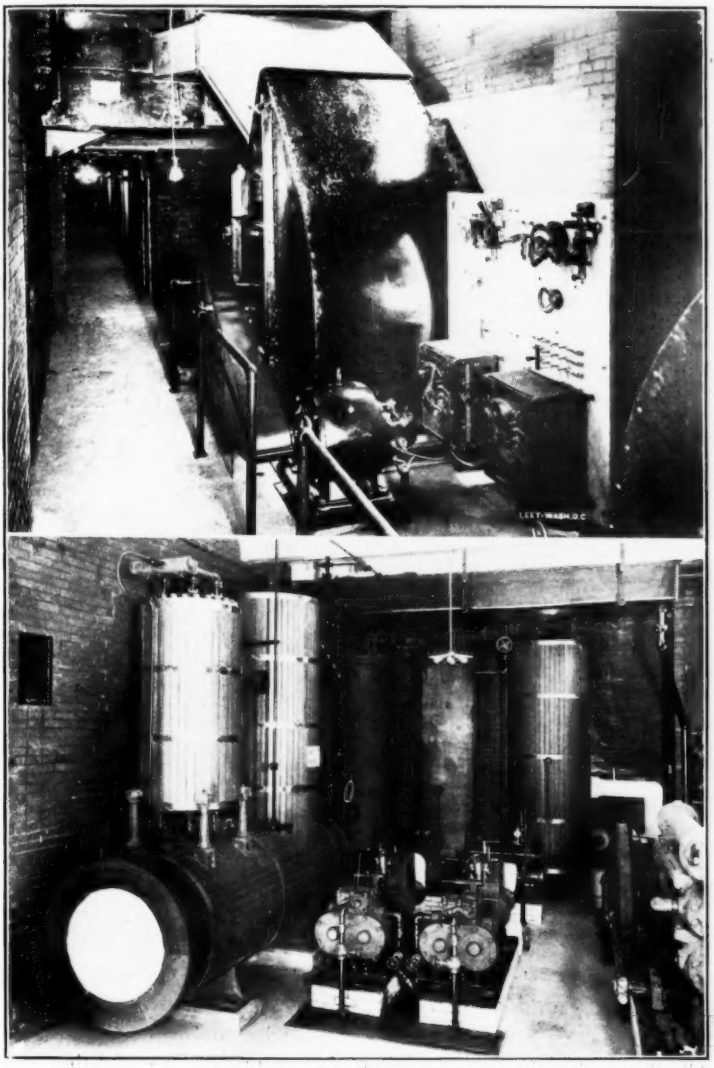
The work of the Bureau in testing engineering instruments and the properties of materials has developed greatly, and Congress has appropriated funds for the construction of a new four-story building, 160 x 60 feet, to be devoted entirely to this work, the erection of which shortly will be commenced. In mechanical testing the activities of the Bureau lie in three main classes; the determination of physical constants, the testing and development of engineering instruments, and the testing of the properties of materials. Now there are many physical constants of great importance to engineers, underlying many plans and calculations. These must be determined most accurately by special experts versed not only in physical science but in some special field.

In the present quarters of the mechanical laboratory the testing of engineering instruments consists more in the study of new

instruments and methods of testing than in commercial or routine testing. The aim is rather to test and standardize instruments as for a central city testing bureau, for example, or for a gas or water company, than to test the individual house meters. In testing a water meter, for instance, a measured quantity of water weighed in a tank can be passed through the meter under various conditions of pressure, piping, etc. The instruments and methods studied for central testing laboratories and for inspectors, operate to raise the standard of measuring water and gas supplies and give the Bureau an ultimate control of such testing apparatus, not to mention the training of men competent to supervise this work for many cities and supply companies.

The testing of gas and electric meters is quite as thorough, and the meter provers of the gas companies are sent here by the manufacturers in order to have the graduations determined and the instruments calibrated after comparison with the standards of volume of the Bureau. Such a tested meter prover and its use thoroughly understood by an inspector at a central testing station, enables individual meters to be tested and the accuracy of their readings checked. Pressure and vacuum gauges, steam indicators, anemometers, and various types of standard testing machines are but a few of the instruments under test in this department, and in all cases the tests are made with measures of length or time, or with weights that have been standardized absolutely.

In the testing of materials the work carried on is rather in the direction of investigational tests than to see whether the materials comply with specifications as is done by the commercial testing laboratory. The Bureau in no way aims to supplant the testing laboratory, but to study new methods, supply standards, control apparatus, and standardize instruments, all in such a way that commercial testing will be facilitated and made more accurate. This comes out very forcibly in the attempt to secure uniform standards and specifications through co-operation with manufacturers and producers, and also through studying the supplies furnished to the United States Government. In its various departments the Government is a large purchaser of many materials, and a number of these are tested at the bureau, both to determine whether they comply with specifications and to study the manufacturers standards and tests. Accordingly a number such as paper, cloth, cement, lubricants, ink, mucilage, etc., are being studied so that standard specifications can be prepared by the Government, which each bidder can understand and which will be definite as well as fair to both parties.

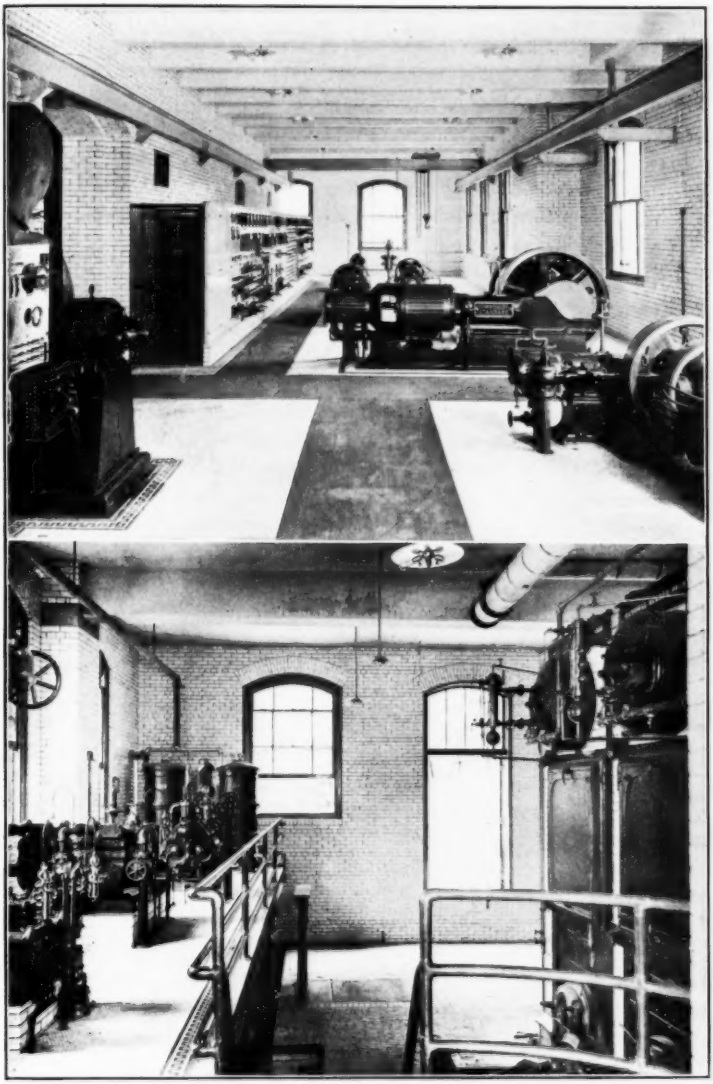


THE VENTILATION PLANT, AND THE REFRIGERATING PLANT FOR BOTH COOLING AND TESTING PURPOSES.

The connecting tunnel between the buildings is seen in the background of the upper picture.

The mechanical building, directly opposite the physical laboratory, contains the power plant, which while not remarkable for its size is a model of arrangement and has an unusual diversity of functions as it must supply all electricity, gas, steam, ventilation, heat, water, etc., to the various buildings and laboratories of the Bureau. It also is of red brick and limestone, but is two stories in height though the large basement, owing to the slope of the land in the rear, is entirely above ground. The building is 135 feet in length with a width of 48 feet increasing to 58 feet in the centre. There are two water-tube boilers, each with 125 horse-power capacity, and these supply steam to three horizontal engines of 120, 60 and 50 horse power, respectively, directly connected to direct-current dynamos, each unit being mounted on a separate concrete foundation independent of the building. There are also various auxiliary engines and pumps which are placed on a platform, level with the floor of the engine room and directly in front of the boilers. Forced draught is provided so that only a short stack is required, while so perfect is the combustion that practically no smoke is emitted. In both boiler and engine room space has been reserved in case it is necessary to add to the plant at any future time. Everywhere there is most abundant light and ventilation, while the use of white vitrified brick and of ceramic floors adds a most attractive appearance to the installation.

Through a three-wire system current at 120 volts is distributed for lighting the buildings, charging the storage batteries, driving the ventilating fans, operating the various motors, and such other power purposes as are required. Adjoining these generators are a number of alternators driven by motors on the main power circuit and furnishing single and polyphase current for experimental purposes, as well as dynamos giving direct current of high potential. All these generators are susceptible of various combinations and transformations for purposes of experiment and investigation. The switchboard panel, 57 feet in length, is adapted for the many experimental requirements as well as the ordinary service of the buildings. Thus there are trunk lines running from this switchboard to other switchboards either in the physical laboratory or in the various laboratories on the floors above, and an experimenter desiring a special current of any frequency or phase has only to telephone the engineer, and by arranging the proper connections secure the same at the outlet in his own laboratory. There is a large storage battery not only for experimental purposes but to carry the load when it is



THE ENGINE ROOM, BOILER ROOM, AND AUXILIARIES.

Another unit has been added to the engine installation and the switchboard extended since the photograph was taken.

desired to shut down the engines, it being of sufficient capacity to meet all of the needs of the building temporarily. The refrigerating room is another instance of the use of machinery both for the ordinary service of the buildings and for scientific experimentation. It includes an absorption refrigerating machine and ice plant, the former having a capacity equivalent to the melting of 30 tons of ice per day. This cold is absorbed by brine which flows through coils in the air chamber of the ventilating plant or through a series of pipes in the tunnel where the base bars and tapes are compared. The brine piping extends throughout the buildings wherever it may be needed, as does water artificially cooled for drinking and for various experimental purposes. In this refrigerating room it is possible to store up cold brine which can be used when the refrigerating machinery is not running. The cooling chamber of the ventilating system is in close proximity to the refrigerating machinery, and the air from the outside, after having been filtered, is forced over a coil containing brine. This removes the moisture and permits dry air to be delivered through the ventilating flues. This cooling chamber can also be used as a low-temperature laboratory where experiments may be performed. A gas machine which produces a high grade of fuel gas from gasoline is also located in the basement of the mechanical laboratory and the gas is piped to all the laboratories.

The instrument shop, well arranged and equipped, permits much of the apparatus to be made under the personal direction of the experts of the Bureau. The machinery is driven by independent motors and skilled instrument makers are employed so that the finest work can be done in the shop.

It is the aim of the Bureau to be a centre of information on scientific testing and measurement, and to stand in the same relation to the manufacturing industries that the United States Department of Agriculture does to the farmers. Already wide use has been made of its facilities, and a most noticeable improvement has taken place in the measuring apparatus and instruments of American manufacturers. The favorable reception by the scientific world of the published researches of the Bureau of Standards seems to indicate that the work is being conducted on a high scientific as well as most practical plane.

STORAGE BATTERIES, THEIR CONSTRUCTION AND USES.

By Percival Robert Moses.

Mr. Moses here concludes his discussion, begun in our September issue, of the application of the storage battery as a means of energy storage in isolated electric plants. The preceding instalment treated of the conditions to which the storage battery system is best adapted, and described the construction and operation of the leading types of batteries on the market. In the following pages the storage battery is considered as an actual part of the generating equipment, under the general heads of the phenomena of charge and discharge, the various types of boosters and other auxiliary equipment adapted to various conditions, and the economies which may be effected by the use of the system. An interesting supplement to Mr. Moses' discussion will be found in a review entitled "The Care and Maintenance of Storage Batteries," on another page of this issue.—THE EDITORS.

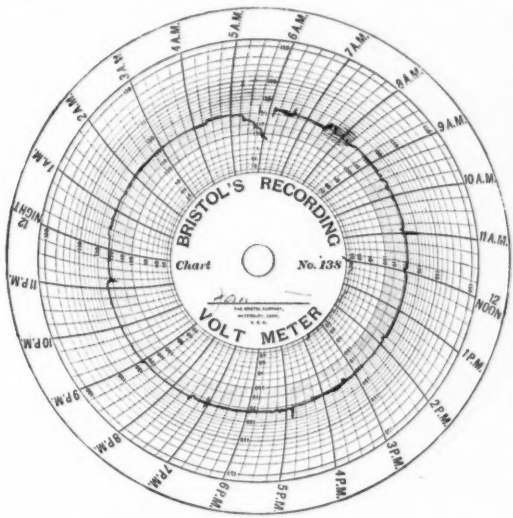


FIG. 15. RECORDING VOLTMETER CHART SHOWING DROP IN VOLTAGE AT END OF DISCHARGE.

IT has been stated that batteries operate automatically to take the fluctuations of the load so that little comes to the engine or dynamo. This condition is technically known as "floating on the line," and the batteries are said to be regulating. This result is obtained by various methods, but all are variations of the general principle of reducing the voltage supplied by the electric dynamo and the booster in series, as the overload goes on, in order that the battery voltage may be sufficiently higher than the combined voltage of dynamo and booster to take all load in excess of the average steady load.

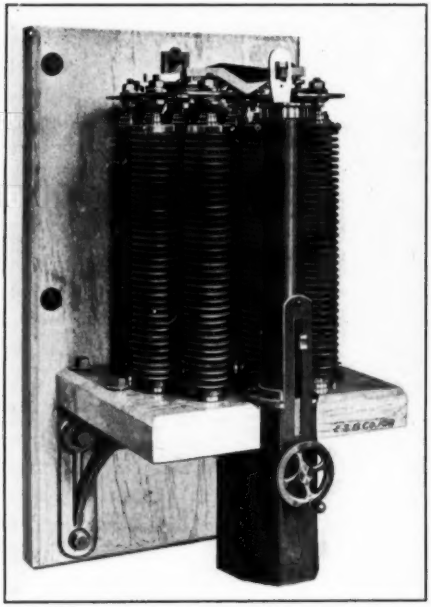


FIG. 16. CARBON REGULATOR.
Electric Storage Battery Co.

It should be explained that while the voltage of each cell is about two volts on discharge, it varies with the state of discharge from 2.08 volts down to 1.8 volts; below this it would drop suddenly as sulphating increased to 1.65 volts and to zero. In charging, the voltage jumps rapidly from 1.9 volts to 2.2 or 2.3 volts, remaining at this point until it rises rapidly toward the end of charge to 2.6 volts. The recording voltmeter chart, Figure 15, shows clearly the varying voltage conditions. This chart shows the voltage of the battery during a 24-hour run under regular working conditions. From 7.45 A. M. to 7.30 P. M., the battery is floating on the line, charging when elevators are not taking current, and discharging when they are. From 7.30 P. M. to 11 P. M. the battery is being charged in order to get it full before the whole load is thrown on. From 11 P. M. to 6 A. M. the battery carries the whole load, including a 15-ton electrically-driven refrigerating compressor, a brine-circulating pump, elevators, and lights. At 5.15 A. M. the voltage begins to drop suddenly, showing that discharge is approaching the danger point, and the plant is started up and the battery put on to charge. If 60 cells are in circuit at the beginning of discharge, they will give 125 volts, and at end of safe discharge this will have dropped to 108 volts. On charge the cells would require after a short period 138 to 140 volts, increasing to 156 near the end of charge; and it follows that the ordinary direct-current dynamo which operates at a steady voltage of say 120 volts would not of itself be able to charge the battery, and if the voltage of the dynamo were raised, it would result in burning out all the lights, etc., on the circuit. Hence, recourse is had to an auxiliary

dynamo inserted between the main dynamo and one side of the battery and designed to give voltages varying from a minimum up to the maximum required for charging, and automatic devices are installed designed to vary this voltage as the load to be carried increases or decreases. The voltage generated by this dynamo is added to that of the main dynamo, and for this reason the auxiliary dynamo is called a booster, the automatic device is called a regulator, and, as the main dynamo is only required to deliver a steady load, the system is called the constant-current system.

The Electric Storage Battery Co. use a carbon regulator consisting of carbon piles (Figure 16), the resistance of which is changed as pressure increases or decreases. An increase in current demand causes the pressure on the carbon piles of the regulator to change, and this causes a flow of current in one section of the booster field-winding opposed to the regular winding, resulting in reducing the strength of the magnetization of the booster field and causing the voltage given by the booster to decrease. The result of this decrease, of say from 20 volts to 4 volts, is to leave the battery voltage higher than the voltage of dynamo and booster, and the current flows from the battery to the load; *vice versa*, when the current decreases, the booster

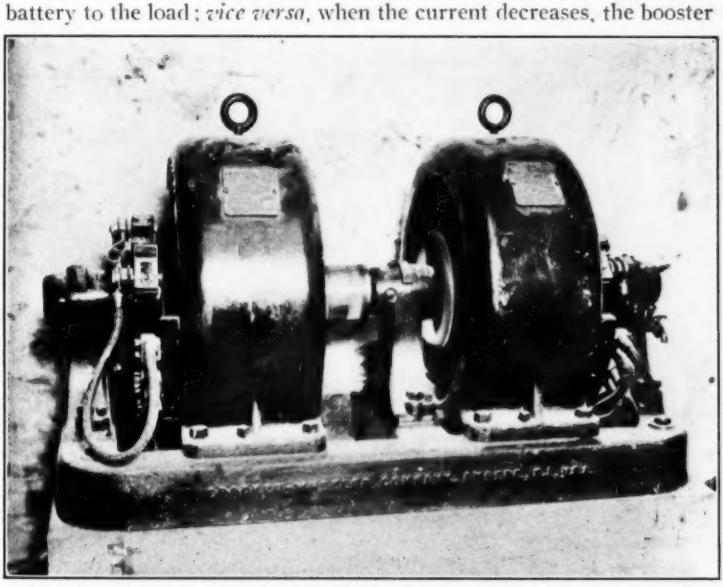


FIG. 17. BOOSTER FOR AN INSTALLATION BY THE GENERAL STORAGE BATTERY COMPANY.
Made by the Crocker-Wheeler Company.

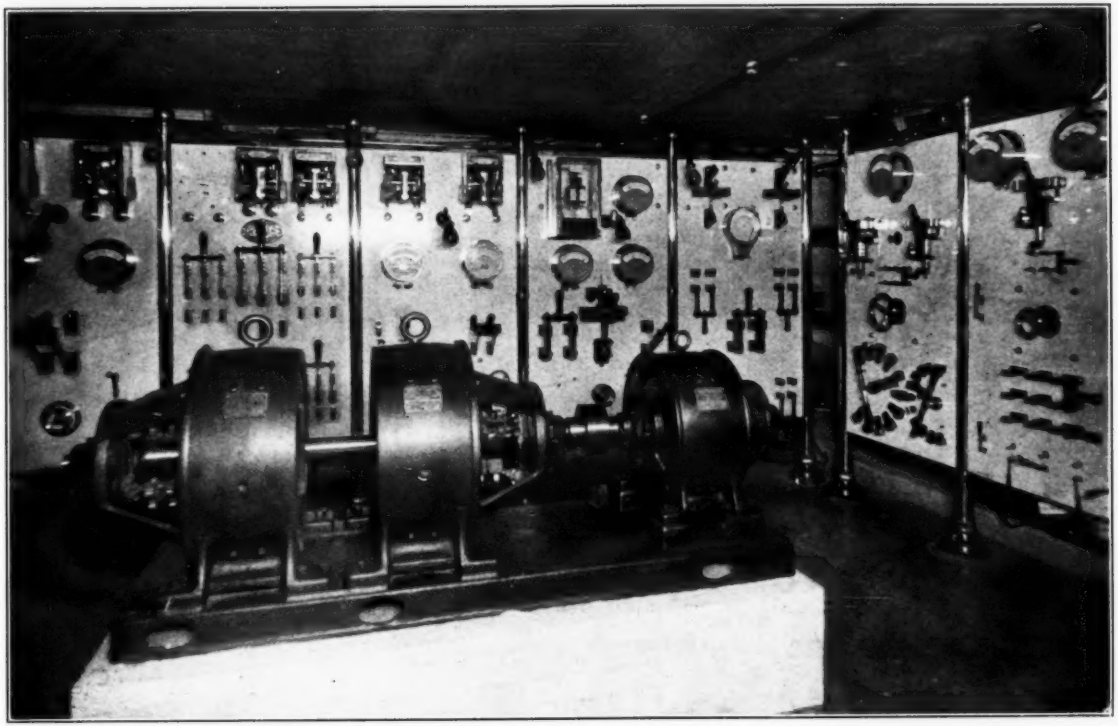


FIG. 18. BOOSTER SET, GOULD STORAGE BATTERY COMPANY.

voltage is increased, and current flows from dynamo and booster to the battery. This arrangement involves a divided field-winding on the booster, and as there is a possibility of the battery reversing the booster and driving it as a series motor, a governor is necessary to prevent its running away.

The General Storage Battery Co. use a shunt-wound booster (Figure 17) and a regulator consisting of a current-carrying coil, or solenoid, exerting a pull on a pivoted arm constant throughout the length of travel, but varying as the current varies (Figure 19). The end of the arm has fingers of unequal length dipping into mercury, and the number of fingers in contact with the mercury bath determines the resistance in the booster field. The pull of the solenoid is resisted by a spring. As the load tends to increase, the current around the solenoid increases, the balance between the pull of the spring and the pull of the solenoid is destroyed and the arm starts to move and continues to cut resistance into the booster field until the current delivered by the booster and, therefore, by the main dynamo is reduced to the required amount, when the balance is again restored. As a matter of fact, the increase in current never reaches the dynamo, as the action of the regulator is instantaneous.

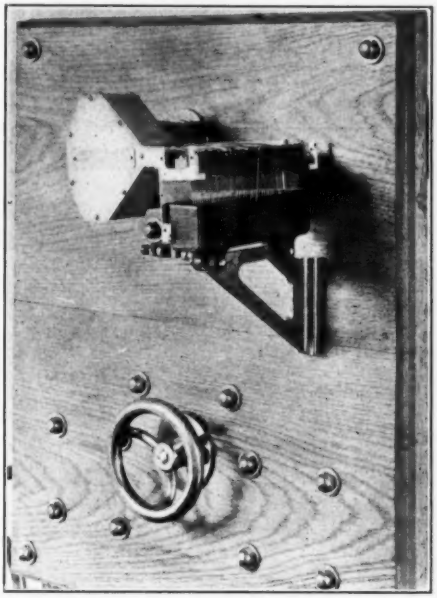


FIG. 19. BIJUR CONSTANT-CURRENT SINGLE-ARM REGULATOR.
General Storage Battery Co.

The Gould Storage Battery Co. use a second dynamo to cut down the voltage (Figure 18), and there are many other ways more or less simple and effective, but all designed with the same object in view. The Westinghouse booster and regulator are shown in Figures 20 and 21.

Boosters for this work require a special design because of the widely varying voltage requirements, and the consequent wide range in magnetization. It is important that they be built by manufacturers thoroughly familiar with the requirements and conditions.

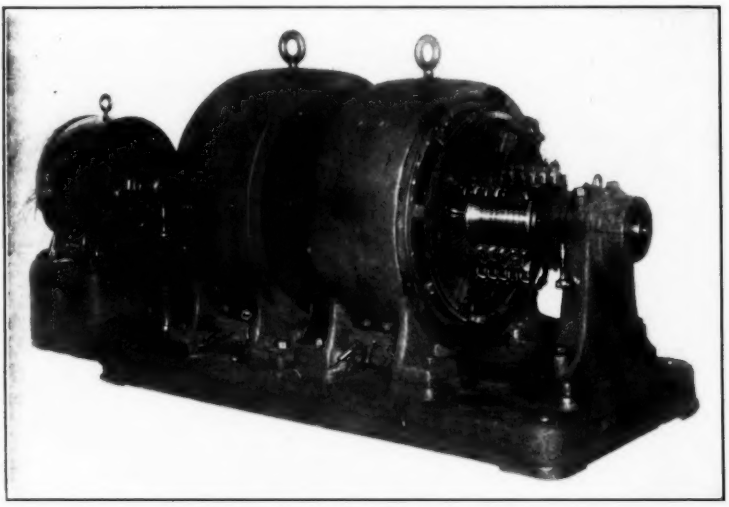


FIG. 20. WESTINGHOUSE BOOSTER.

Where the battery is to be used for regulating during the day, and after regular hours for lighting, etc., it is evident that the booster must not only have a capacity sufficient to give the average of the day load, but sufficient additional capacity to supply the load taken out during the night, unless it is possible to cut the battery out of regulating service for a considerable time after discharging. Where the battery is only to be used for regulation, its capacity need only be equal to the average demand.

If the battery is not to be used for regulating, but is intended merely to supply peak loads or night lighting, an ordinary shunt-wound booster controlled by hand is all that is needed.

Note has been made of the drop in voltage from 2.08 to 1.8 volts on discharge, and this necessitates the use of additional cells known as "end cells," to be thrown into circuit as the battery becomes discharged, in order to maintain the original voltage on lamps. A special form of switch (Figure 24) is required to prevent short circuiting of the cells when they are being thrown in; and where cells are large, the switch is operated by a motor—in some cases automatically.

Batteries are rated generally by their ampere-hour capacity on an 8-hour average discharge rate; for example, 320 ampere hours is 40 amperes for 8 hours with a final voltage of 1.8 or over per cell. If it is desired to discharge the battery in one hour, the capacity will be about one-half this amount, that is, 160 amperes for one hour, but the momentary permissible discharge on regulation is equal to the full capacity for 8 hours, that is, 320 amperes, and even greater momentary discharges may be taken without damage.

The cost of batteries installed with switchboard panel varies with the voltage required; i. e., a 240-volt battery with a capacity of 160 ampere hours will cost more than a 120-volt battery with 320 ampere-hours capacity, because of the greater relative cost of supporting racks, and the larger number of connections and cells.

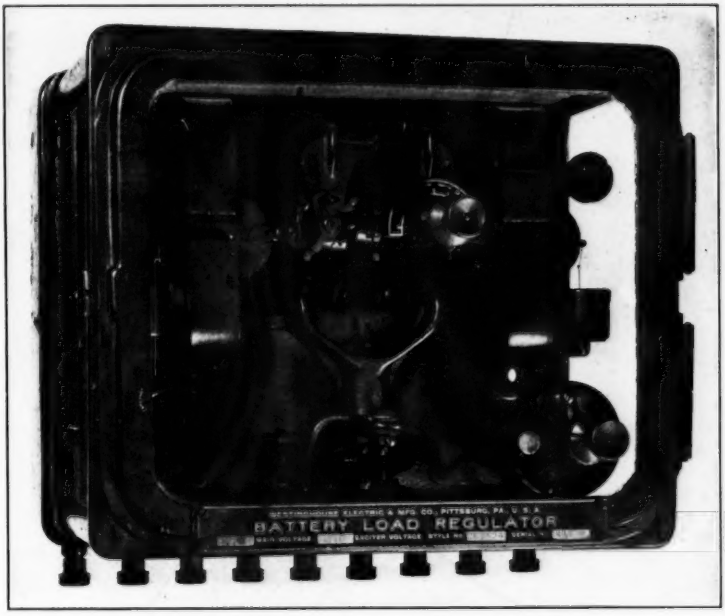


FIG. 21. WESTINGHOUSE BATTERY LOAD REGULATOR.

For small batteries used in connection with the regulation of elevator loads, the cost will be between $100 and $125 per ampere-hour capacity at 8-hour rate at 250 volts; or between $400 and $500 per kilowatt capacity at 8-hour rate; for example, a battery giving 40 amperes at 250 volts for 8 hours would have a kilowatt capacity at 8-

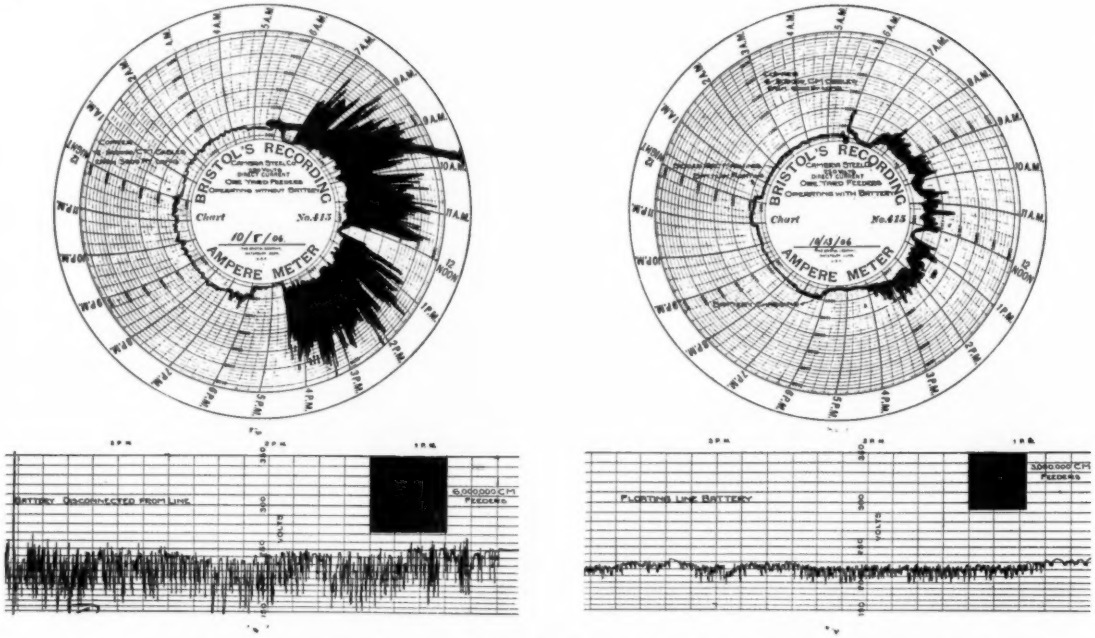


FIG. 22. VOLTAGE AND AMPERE CHARTS, WITHOUT AND WITH BATTERY ON END OF FEEDER TO ROLLING-MILL MOTOR.
Without battery, on the left; with battery, on the right. Greene Storage Battery Co.

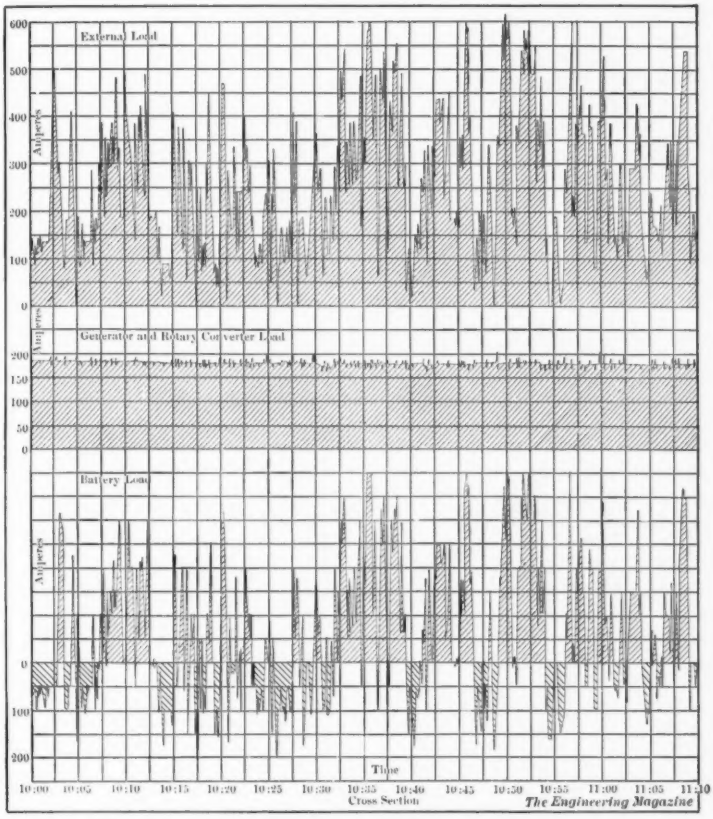


FIG. 23. CHART SHOWING DIVISION OF LOAD BETWEEN DYNAMOS AND BATTERIES IN COLORADO PLANT; WESTINGHOUSE MACHINE COMPANY.

Top indicates total load, middle the almost steady load carried by dynamos and rotaries, bottom the wildly fluctuating load carried by battery.

hour rate of 10 kilowatts, and would cost between $4,000 and $5,000. Such a battery, however, would be capable of safely taking care of fluctuations up to 100 kilowatts, and if the plant capacity to take care of this amount of fluctuation had to be provided, it would cost between $6,000 and $7,000, so that the first cost would be less with the battery than without, unless part of the plant capacity, such as boilers and stack, were required full size to take care of heating or other low-pressure-steam requirements.

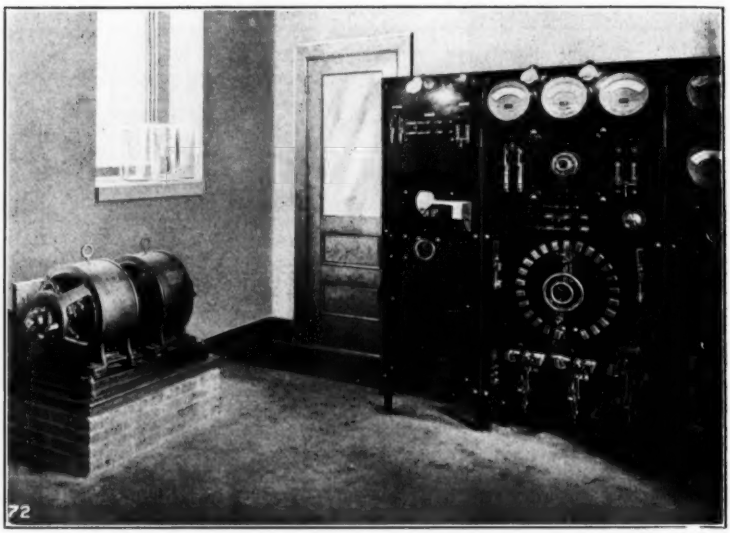


FIG. 24. BOOSTER AND BATTERY PANEL, ST. URBAN INSTALLATION, NEW YORK.
General Storage Battery Company.

In general, if fluctuating load propositions are carefully designed, the total installation cost with a battery will be a little higher than without but the operating cost will be much less.

In street railway or rolling mill work, there is a further advantage derived from the use of a battery, viz., the reduction in size of feeders, control switches, etc., made possible by the installation of the battery close to the fluctuating load. In such instances the feeder from the generating plant to the battery may be designed for the charging current, i.e., the average current, instead of for the maximum current, an important factor where power is to be transmitted any distance. The two charts in Figure 22 (General Storage Battery Co.) show these facts clearly in connection with a rolling mill installation. The chart on the left shows the size of feeder to be 6 million circular mills, and a variation in voltage at apparatus of over 100 volts, from 250 to 150, while the chart on the right shows a feeder half the size, and a maximum variation of 25 volts.

EFFICIENCY AS A BASIS FOR OPERATION AND WAGES.

By Harrington Emerson.

IV. STANDARDS; THEIR RELATIONS TO ORGANIZATION AND TO RESULTS

The first part of Mr. Emerson's essays called attention to the general inefficiencies existing everywhere; the second, to the peculiar national qualities that have thus far helped industrial countries to mitigate the losses due to inefficiency. The third paper pointed out the great need of supplementing the old and cumbersome line organization that pervades industrial management with modern staff organization. This fourth part shows that the inspiration of staff lies in severe and high standards of great minuteness. The fifth and sixth instalments of the series will give the practical results secured by supplementing the usual line organization and current methods with staff organization and staff ideals.—THE EDITORS.

PRESERVATION and perpetuation is one of Nature's most important laws; therefore line organization, which is self-perpetuating, is essential, it being a detail whether the chief and officers of the line are individuals or commissions or a semi-staff. Line organization, from its nature, will always be mediocre and inefficient unless handled by an extraordinary genius like Napoleon. The mediocrity is not one of individuality but of organization. Promotion is not by merit, since this would destroy the essential feature of line (its property of self-perpetuation), but advancement is by seniority. The youngest member is as capable potentially as the highest, and whether he rises to supreme command in five years or in forty-five depends on opportunity. When he has reached the age of retirement he gives way to a junior as one day gives way to another. There was nothing worth preserving and the elimination of the temporary head produces a desirable wriggle of life all the way down the line.

Line organization needs few standards, usually crude and often fictitious. Seniority or precedence is one of its standards, and closely interwoven is the fundamental standard of immediate and unquestioning obedience almost as automatic as the obedience of sheep to the leader. This simplicity of standard eliminates mental, moral, and physical perplexity. A chief of line may have many personal standards. He may not permit men to be recruited for his guard unless seven feet tall, the idiosyncrasy of the first king of Prussia, or he may uniform them in tall beavers and scarlet coats, or he may dress them

like cowboys and call them rough riders, or as in the German and French and Russian armies there may be most punctilious standards imposed as to dueling.

Line organization can be defined as a self-perpetuation of a good average with the one standard of obedience.

Because it is the exact opposite, staff is a strengthener to line. It is not self-perpetuating but distinctly selective. The youngest captain in the German army assigned for staff duty, is perhaps the highest special authority on aeroplanes. Promotion is not upwards but outwards, just as the Wright brothers, who began by specializing on aeroplanes in their home field in Ohio, are now the recognized authorities in the United States, France, England, and Germany, in aeroplanes, but in nothing else.

Instead of there being one main standard, obedience, causing no perplexity—instead of subsidiary fanciful standards—there is an unlimited multiplication of scientific standards, higher than all personality; and the staff expert, instead of receiving all the law and gospel from his chief, receives general principles only, but himself furnishes his chief with personally perfected standards, which it is the duty of the chief to adjust and incorporate in the general plan.

A staff without general standards, a staff officer without special standards, either expressed or felt, is a misnomer.

The standards of the staff are not scientific abstractions, but are evolved for the use of the line, the sole justification of the standards being that they will make line work more efficient. Staff standards being for the benefit of the line and often intrusted to line officials, must be put in the form of permanent instructions so that all may understand what is being aimed at, and deviations by the line be marked and reprimanded.

During the Cuban campaign, in a road over which many hundred army wagons were to pass, there was a mud hole. The first transport wagon, obeying the command to proceed to destination, floundered into the hole, had to be unloaded, dragged out, and reloaded. The crew had neither authority, skill, nor equipment to mend roads, so they passed on. Also there were no written staff instructions as to what a line official should do when he found the road impassable, so the second wagon coming along a few hours later, plunged into the same hole and experienced the same delay and trouble. In turn each of the several hundred wagons repeated the same performance, and although this road was in constant use for several months no attempt was made to mend it. Had there been as much sense of staff as in

ant-hill activities, the first wagon would not have passed on without bettering the conditions for those who follow, instead of leaving them worse; had there been even elementary staff, one wagon only would have gone into the hole, which would then as a matter of course have been eliminated. Had there been perfected staff, even the first wagon would not have passed over the road until it had been put in condition.

A sign post definitely stating distance, character of road, steepness of grades, to next town, is not in any way an imposition on or impediment to the wayfarer, whether on foot or in automobile, but is a valuable help. The sign post is a staff, without authority, except as imposed on the line by a line officer, a staff without value except as to its own special and limited information.

Staff standards are infinite and ever-changing. The best practice of yesterday is the laughing stock of today. The work of the expert is never done. The aeroplane flight of 6 miles last year becomes 60 miles this month, 600 miles next year. The chief of staff, who is to inspire the search for higher standards, who is to handle them with common sense, must himself be governed by elemental natural truths, his standards, used as a test for all the others, and these highest standards are psychical and physiological rather than physical. The four psychological requisites for a chief of staff are: (a) Faith, in men, in equipment, in methods, and in standards (b) an enthusiasm that inspires and creates confidence, (c) ultimate highest ideals, (d) very great rapidity of action.

Faith in men, faith in equipment, faith in methods, faith in standards must be so great as to inspire a contagious enthusiasm not only in the junior staff members but also in all the members of the line from commander-in-chief down to private. No man is fit to be a member of a staff who does not delight in his work, who does not consider it quite the keystone of the arch, who does not bend it wholly to the interests of the line, so that the line will recognize that through staff presence and staff endeavor, line work is made safer, higher, more pleasurable and more profitable.

The chief of staff must believe that the great majority of employees, nine-tenths, at least, can be easily influenced to do what is right, and prefer to do what is right, and that if the right course is made easy, it will be automatically followed, just as most people naturally keep to the sidewalk, although there are no rules ordering them to do so. Policemen are armed with clubs not to intimidate the well behaved many but to terrorize the exceptional few. After the first prejudice against any innovation is overcome, staff standards must continually appeal to those for whom they are set up.

The chief of staff must assume, until the contrary is proved, that existing equipment and existing facilities utilized to fullest efficiency can meet most requirements, that it is better to improve than to substitute, that Goliath can be slain with a sling and that the western road to India can be discovered with a caravel.

No man is fit to be either chief of staff or staff junior who does not have and adhere to high ideal standards. This fidelity to abstract principles is necessarily foreign to the line. A type setter is a member of the line. He achieves, obediently following the manuscript; but the proof reader is a member of the staff and maintains standards. Between them, perfect work is turned out.

The chief of staff and all his juniors must be alive to the value of rapidity of action. Seconds, minutes, hours and days are to the staff what hours, days, months and years are to the line. Staff ideals of the value of rapidity are found in the instantaneous action of a boxer or fencer where delay of the hundredth part of a second to meet an expected condition may result in death; are found in the activities of the weather service which receives reports from territory 6,000,000 miles in extent, compiles and digests the information, and publishes tomorrow's weather before noon today, to all the world over land and sea; a delay of a few hours would make the whole work valueless. Staff ideals of speed reacting on all the line are found in the work of a daily paper which collects the news of the whole world until the night is half gone, goes to press at two in the morning, and reaches distant customers at 6 a. m.

A proposition was made to the line officers of a large corporation to reduce expenses $2,000,000 per annum. Whatever the time required to accomplish this, every day's delay caused an irretrievable loss of $6,666; yet details that ought to have been decided in 8 minutes were allowed to wait for 8 months. Line traditions vitiated staff ideals and as the line lasts forever it is not imbued with speed ideals. It was quite in accordance with line tradition that the wars between France and England lasted 100 years, that the religious wars in Germany lasted 30 years, that the wars of Frederick the Great lasted 7 years, that the French European wars lasted 26 years, that the war of the American revolution lasted 7 years, the wars of the Rebellion 4 years—but that the staff-prepared war of Von Moltke's Prussian army against twice as strong a territorial and numerical coalition lasted 2 weeks, and Von Moltke's staff-prepared war of Germany against France captured the French emperor and the French armies and ended the French empire in 7 weeks after outbreak.

In line, there is very little planning but a great deal of organization; in staff, it is all planning and very little organization.

Owing to absence of staff as part of their own organization, lines, all over the world, have been forced to depend on outside staffs, whose inspiration was generally tinged with pecuniary self-interest, so that the great shops and railroads and other industrial concerns have been as to men, machines, materials, and methods over-supplied and over-equipped, as when a $100,000 saw mill is erected to handle a $50,000 lumber tract. Many hundred million dollars have been spent in the last decade on fanciful betterments, when greater returns could have been obtained by standardizing what was.

In marked contrast to the lavish expenditure for inadequate returns from improvements in industrial and transportation concerns is the small expenditure and enormous return brought about in agriculture. The present depression in the great industrial division of American activity and the almost giddy prosperity of the agricultural division at once illustrate the fundamental difference in results and in methods obtained from line and staff activities respectively. The farmer is not lazy, he is not troubled by union limitations, and he has the enormous spur of direct and personal increase of reward for increased or more intelligent effort; he has moreover been at his business from birth; but the average result in crops is only about 30 per cent of what it ought to be.

There is no reason for assuming that industrial activities, entrusted to men whose interest goes no further than their daily wage, who were not born to the business, will average any higher in efficiency than the farming class, and in fact there is just as much difference between the average crop and the expert's crop as there is between the average output of a man and machine and the expert's output from the same man and machine. Two different influences are revolutionizing agriculture—the isolated special genius, and the staff adviser. The industrial field has had the isolated special genius but as yet very little staff assistance.

Because these essays on efficiency are applicable particularly to shops and railroads it is better to use illustrations from agriculture, since it is much easier to see the mote in the brother's eye than the beam in our own. Therefore the yield of potatoes will be used in illustration. What is the limit of yield of potatoes from an acre of ground in the United States? The average yield per acre over a series of years is 96 bushels. Shall we therefore set 100 bushels as standard 100 per cent efficiency?

The lowest average in 1907, 65 bushels, occured in the great agricultural State of Kansas; the highest average was in the desert State of Wyoming, 200 bushels to the acre. The highest average in Wyoming is due to one man, who issued a challenge of $1,000 open to all the potato growers of Colorado, that he would raise on his Wyoming farm more potatoes per acre than any one could raise in Colorado, provided further that if he won the contest yet failed to raise 1,000 bushels per acre, he would forfeit the whole of the stakes, $2,000, to charity.

It is psychology, not soil or climate, that enables a man to raise five times as many potatoes per acre as the average of his own State, ten times as many per acre as the average of the United States, thirteen times as many as the average in the better soil and climate of Kansas. An easily attainable standard of potato raising is therefore not 100 bushels but 500 bushels which can be called 100 per cent efficiency.

On this basis the average of the United States is 19 per cent, the average of Kansas 12 per cent, the production of the Wyoming champion 200 per cent efficiency. If the United States attained as to potato raising an average efficiency of 50 per cent, the increased value of the crop in one year would be sufficient to pay for the Panama Canal; or, the acreage and labor devoted to potatoes could be reduced to 40 per cent of what it now is, and still yield as many potatoes.

Undoubtedly the potato champion, in a more favorable climate, where, with irrigation, three crops are possible, as in the Yaqui Valley in Mexico, would raise 3,000 bushels per year per acre. They would cost him more per acre but less per bushel than any other potatoes in the world.

Individuals of this kind have inspired the Agricultural Department at Washington, working in conjunction with State agricultural staffs, to standardize conditions for all staple agricultural products.

It has recently been asserted that with selected seed a standard attainable yield of wheat is 50 bushels per acre per year. The actual yield is 14 bushels; the total 650,000,000, when it ought to be 2,500,000,000 bushels—yet there are charity bread lines in New York.

With a standard of 50 bushels per acre the efficiency average of the United States is only 28 per cent, the money loss at constant price over $1,000,000,000 per year.

The staff experts of the Agricultural Department have enabled Texas cotton growers to raise one bale per acre. Selected seed, suit-

able fertilizer, systematic cultivation is all that is required. The acreage of cotton is 32,000,000 the production only 12,000,000 bales; the efficiency is 37.5 per cent and the annual loss due to inefficiency about $1,000,000,000.

Italian bees in California raise twice as much honey as they do in Italy. The Californian bees do not work as hard, they live longer because most of the disagreeable work is eliminated. The staff experts advising the bees are men who standardize conditions both simply and effectively. The bees make honey instead of wasting time on hives, on foundations, on comb, and on long journeys to semi-barren flower fields.

The potato expert increased the efficiency of his fields to ten times the average; the owner of Alaskan seed wheat increased his yield to fourteen times the average; the corn and cotton staff experts have through their advice enabled whole counties of farmers to double the average yield of corn and cotton; the making of better conditions has increased the average yield of honey 100 per cent.

If we could put ourselves in touch with the feelings of plants we should probably find that there was much more enjoyment to potatoes in growing 1,000 bushels to the acre than in growing 67 to the acre. Intensity of production does not mean physical exhaustion, but favorable conditions. Similarly, intensity of human production does not legitimately mean, and ought never to mean, the physical exhaustion of an over-worked victim, but should be due to the joyous stimulus of perfectly standardized conditions.

Examples from agriculture have been selected because far more has been done to establish standards of attainable production in agriculture than in factories, shops, and mechanical trades. The plant also will always do the best that circumstances permit and the circumstances are largely controllable. A man will rarely do his best even if circumstances are favorable; but as an offset it is more easy to control factory, transportation, shop and handwork conditions than to control seasons, climates, diseases, and insect pests. On the whole, the efficiencies of industrial organizations are no higher than those of farming activities, and as staff standards indicate possible increases of 200 per cent in agricultural yields, so staff standards and staff assistance will bring about 200 per cent increased efficiency in materials and services in industrial organizations, including railroads. Tests show that this can be done.

The standardizing of belt practice by staff study has increased the average life of belting more than six-fold, has reduced belt failures to

one-sixth of what they were, has decreased annual cost to less than one-seventh.

The discovery and perfection of high-speed steels did not originate in any shop but was exclusively developed by men whose ideals and practices were those of the staff, and high-speed steel accomplishes four or five times as much as the old carbon steels.

Staff selected and designed abrasive wheels cut four times as fast as the old grindstones and every grade needed can be made to order, standardized for each different kind of work; files that are standardized as to quality last five times as long and cut much faster than the usual good commercial files.

Wherever the staff expert turns, he finds that standard time and cost for some units of work can be reduced to one-half, for other units to one-quarter, occasionally to one-tenth, the average time for the unstandardized work.

Railroad practice has many standards, chiefly those of specification, construction, and times for passenger trains. No railroad has ever determined any cost standards either for maintenance or operation of equipment, maintenance of way, or consumption of fuel; yet there is no railroad in the country on which each one of these cost standards could not be determined in a very short time and with very close accuracy, at a cost equal to the saving effected in a single month.

When each unit of locomotive repair is standardized, the sum of the units shows a cost between $0.03 and $0.06 a mile for maintenance. The actual average costs on the railroads are between $0.06 and $0.12, therefore twice what they ought to be. The standardized cost of maintaining freight cars is as low as $30 per annum. Actual average costs run from $45 on some roads to over $100 on others. Standards of maintenance of way vary, but innumerable assays of actual work show a maintenance-of-way labor efficiency of scarcely more than 30 per cent.

Staff determinations with a dynamo car showed that 1,000,000 B. t. u. in the coal were amply sufficient to furnish power to move a 1,000-ton train one mile. The actual coal charged to locomotives always contained more than twice as many, often three times as many, B. t. u.

The average mileage of the locomotives of the United States is close to 30,000 per year, about 82 miles per day. Average mileage of a freight car is about 25 miles per day. Staff standardization in locomotive repairs not only decreases the cost to one-half as much per mile, but also increases the mileage at least 33 per cent.

Locomotive repairs cost twice what they should, not because men in charge are not of the highest ability and experience, but because these men are so hampered by line organization that it is almost impossible for them to evolve standards or to maintain standards when evolved. Standards are always of the microscope, of the assayer's balance, of infinite patience applied to the smallest of details. It is not important that absolute zero is at — 273 degrees and that the highest temperature in the sun is 10,000 degrees, but it is important that human life is snuffed out if the temperature of the body rises 5 degrees centigrade.

It is not important that space is so vast that it takes hundreds of light years for the light of distant stars to reach us, wireless telegraphy on a stupendous scale, but it is important that the yellow fever bacillus may lurk in the saliva of a mosquito, so small that the microscope has scarcely yet discovered it.

It is not important that pressure varies from nothing in vacuo to so much at the deepest spots in the sea, that an air bubble taken down there becomes heavier than water and cannot rise to the surface, to so much at the earth's center, even if there were free opening to the surface, that the air would be heavier than gold, harder than titanium, so that a needle could not be driven into it, yet if in it, would slowly move surfacewards until specific gravity of air and needle were the same. These facts, interesting though they are, do not concern us as much as the fact that men cannot work on high mountains without danger nor in caissons without risk of the "bends," and that half the power put into air compression is lost in pipe leaks.

The staff chief and his assistants in search of standards, are not using bolometers to measure the ten-thousandth part of a degree, nor the spectroscope to measure the speed of advance or recession of the fixed stars, nor ruling diffraction gratings 900,000 lines to an inch, nor are they interested in either the North Pole or in the transit of Venus; but they are searching for common, every-day, practical and attainable standards of which astounding few have been determined.

Time is infinite, but that does not concern us so much as that five minutes of suspension of breathing or heart beating carries us over the boundary that separates life from death.

Congress has determined that a dollar (not now coined) shall consist of 25.8 grains of gold nine-tenths fine, but it may be a shock to learn that Congress has never determined the grain or any other standard of weight or of length or of time. The United States Treas-

ury Department has adopted a gallon and a bushel, but neither is in accordance with the legal standards of Great Britain. They not only differ from the present standards of Great Britain, being respectively 17 per cent and 3 per cent smaller, but they also always differed from the discarded English standards from which they were derived.

On April 15, 1903, the Superintendent of Weights and Measures, not Congress, directed that the international metre and kilogramme should be in the future regarded as fundamental for metric and customary weights and measures. Congress, which has failed to legalize standards either of weight or of length or of capacity, has however standardized the spelling of Porto Rico and the motto "In God We Trust" on the dollar, and it is safe to say that Congress has concerned itself more with this motto than with the fact that all the thousands of millions of dollars of railroad and industrial shares sank in October, 1907, 33 per cent in value in a few weeks, and that the earning power of hundreds of thousands of men, eager to work, fell from an average of $2.00 per day to nothing.

In Germany in the polytechnic schools as late as 1875 and perhaps now, mediæval standards of proper procedure in all matters appertaining to students' duels were more definite, punctilious, important than surprisingly lacking modern standards of scientific accuracy.

These examples of American legislative and German scholastic insistence in the puerile and neglect of the all-important almost give the dignity of natural law to the statement that in standards insistence and excitement are in inverse proportion to practical every-day importance, and with such high examples as Congress and German Universities it is not surprising that in the line organization of American industrial enterprises there is more sensitiveness about prerogative than in Congress itself, more alertness to take offence at the unimportant than in the German student.

The difficulties blocking the path of the radical improvement that would immediately result from supplementing the line with staff and standards, are the sensitiveness and apprehension of the line that, in some way it cannot explain, staff activity and application of standards will reflect on line ability, as if in the round-the-world automobile race, the benefits of good roads from Berlin to Paris and the speed made over the good roads, reflected on the capacity of the automobile drivers, who made slow yet astonishing progress through Siberia.

INTERNAL COMBUSTION FOR ROTARY PRIME MOVERS.

By Edward C. Warren.

The suggestion put forward by Mr. Warren in this article, of the possibility of producing a commercial fuel which will contain in itself the oxygen necessary for complete combustion, strikes at the root of the main difficulty encountered in the application of the internal-combustion principle to rotary prime movers—the necessity of expending a large amount of the power developed for the compression of the air required to support the combustion process. Mr. Warren is confident that the discovery of such a fuel, cheap, convenient and easily controlled, through the co-operation of the engineer and the physical chemist, is much more than an attractive possibility and in the following pages he indicates the general lines along which, he believes, success may be attained.—THE EDITORS.

THE future of power generation will be vitally affected by the application of the internal-combustion principle to rotary prime movers. The attainment of a reasonable degree of economy in the conversion of fuel into mechanical power demands the direct application of the expanding gases of combustion to the moving element of our motors, whether that be a reciprocating piston, the vaned rotor of a static-pressure rotary engine, or the multi-bladed disc of an impulse or reaction turbine.

The mooted question of the adaptability of the turbine type to use with the gases of combustion of liquid fuel as motive agent seems to have been finally settled in the affirmative, in so far as concerns the actual availability of these gases as a motive fluid, by those interested specifically in the development of this type of engine. There exist, however, by general acknowledgment of all known interested authorities, certain very serious practical difficulties in the application of the involved theories, chief among which is, by common consent, the problem of compressing the requisite supply of atmospheric air for the support of combustion. This difficulty has been clearly set forth by various investigators, notably Professor Charles E. Lucke and M. René Armengaud, whose researches and writings have so illuminated this entire field of power development.

The inspiration for the present discussion does not arise from any special interest I feel in the application of the internal-combustion principle to the operation of turbines, though to many, perhaps to nearly all, the possible readers of this article, the principal signifi-

cance and interest in the ideas and suggestions advanced will lie in the fact that a solutioin of this problem is certainly indicated.

I have for many years struggled with this problem of air supply for combustion in various applications of the internal combustion principle to the production of power. I have found, as others have found, that this is by far the most troublesome and expensive feature of this method of generating power. From one-half to three-fourths of the total mechanical capacity of the "converting" mechanism is invariably engaged in the work and operations incidental to furnishing the requisite volume of air, compressed to the required degree, to permit of its introduction and incorporation with the fuel. This means an enormous power loss; but what is in many cases of more importance, it means excessive weights and bulk of machinery to produce a given power. The ordinary four-cycle oil engine, since it makes but one useful power stroke out of a possible four, produces less than one-fourth its potential mechanical capacity for power were it possible to operate on a steam-engine cycle, the piston delivering power continuously, instead of for three-fourths of its working time absorbing part of the power generated during the one power stroke.

This illustration holds good practically wherever it is attempted to burn the fuel under pressure and compress the air for combustion.

As to the remedy for this state of affairs, I propose merely to present here formulated conclusions based upon an analysis of the broad problem of internal combustion for power. When a specific problem is found to be inherently difficult, or perhaps insoluble, it may be well to inquire if there is no other path leading to our goal by which the necessity of meeting this insoluble enigma may be altogether avoided.

Upon analysis our problem has appeared to be about as follows:

We must apply the expanding gases of combustion directly to the work of impelling our "converting" mechanism, if we are to achieve reasonable economies in the converting of fuel energy into mechanical energy.

To do this involves burning the fuel under pressure.

The fuel must be supplied with oxygen, hence we must force in a supply of air against the working pressure.

Compressing air is an exceedingly troublesome and expensive operation. Supplying 235 cubic feet of atmosphere per pound of combustible at a pressure of 100 pounds or more constitutes an all but prohibitive working condition.

Examining the problem more closely: The fuel needs oxygen; the fuel consists practically of carbon, or hydrogen and carbon combined, and must have a certain proportion of oxygen supplied in order that combustion may occur. True, the fuel always contains within itself a small proportion of oxygen, but not sufficient to sustain combustion. Does not the thought naturally arise: If the percentage of oxygen were greater, less air would be required for combustion? And is it not readily observable that some forms of fuel require much less air or oxygen for combustion than others?

Here, then, we find a suggestion: If only we had a fuel that contained *enough* oxygen, we should have no need to furnish air to insure combustion. And this may be the key to the solution or *elimination* of this problem of air for combustion.

The available fuels are incomplete fuel substances, inasmuch as they lack an essential element of combustion, oxygen, and it is the problem of introducing the missing element that is giving us all the trouble.

The process or processes involved in obtaining a supply of oxygen and incorporating it with the incomplete fuel substance constitutes a *manufacturing operation* which we have been trying to carry on in conjunction with the combustion of the fuel and its utilization in a prime mover. The deduction is obvious. If the fuel is not completely manufactured and a further manufacturing process is necessary to render it combustible under the conditions imposed, the work of completing its manufacture should be performed in the manufacturing or refining plant. But, it will naturally be asked, how are we to add oxygen to a fluid or solid or powdered fuel in such a way as to render it independently combustible? It is the purpose of this article to suggest in general the manner in which this may be accomplished and a fuel provided which shall eliminate the necessity of compressing air for combustion.

The power engineer who has always been accustomed to dealing with the fuels available in the market, and who habitually regards a supply of atmospheric air as the natural and necessary concomitant of combustion, will probably regard as revolutionary a proposal to provide fuel especially prepared for power purposes and perfectly adapted to his needs. He has so long accepted unreflectingly the various hydrocarbon products of petroleum which have been thrust upon him as fuel, and has so long expended his energies wrestling with the trying problems of adapting his mechanisms to their use, that a suggestion to shift a part of his burden to the shoulders of the

fuel manufacturer will doubtless strike him as a Utopian dream. However, this is exactly what it is here proposed to do.

Given a fuel containing all the elements of combustion in proper proportion, the engineer's problems will be vastly simplified. His mechanism may then be purely a power-producing mechanism and his losses will be only the inevitable losses due to conversion of energy from one form to another. At present, in calculating the efficiency of the internal-combustion motor, a heavy loss is charged to loss of power in compression, friction, and heat losses during the idle or *manufacturing* strokes, amounting on an average to probably 50 per cent of the total losses. This loss is not properly chargeable against the motor. It would be equally reasonable to charge against the motor the energy expended in refining the oil from the condition of crude petroleum.

The fuel, as finally actually applied and ignited in the motor, is a complete, fully prepared combustible. As it comes from the earth it is an imperfect and unsuitable fuel substance. When introduced into the cycle of a motor it is still an incomplete and unsuitable fuel substance, inasmuch as it requires the addition and admixture of another essential fuel element, oxygen.

Now, to the power engineer, oxygen and air appear to be regarded as synonymous terms. To obtain oxygen he must needs deal with atmospheric air. Even in technical works the volume or weight of air required for the combustion of various fuel substances is frequently set forth in manner and language inferring that the mixture atmospheric air is, as such, an essential element of combustion. Of course, on reflection, any engineer or, in fact, any layman, knows that it is the oxygen only of the atmosphere that plays any part as a supporter of combustion: that the predominant element, nitrogen, is under all ordinary conditions of combustion, an inert and troublesome factor which impedes and retards by its presence the process of combining the carbon and oxygen atoms. In fact, it is perfectly known, on reflection, that the only reason that we deal with or consider the atmosphere in this connection is that the atmosphere is an ever-present and available source of oxygen.

But, to refer to our physical chemistry, we find that "oxygen is the most abundant and widely diffused of all the elemental substances," existing in combination with other substances in all three of the physical forms of matter. This, too, is a familiar fact, but one of the many in this domain of physical chemistry upon which we do not seem to have reflected. If oxygen is the most abundant and widely

diffused of substances, and if it is available in concentrated as well as gaseous form, why do we choose to seek our supply in the atmosphere, where it is so highly expanded and associated with so large a proportion of an inert and troublesome gas? Let us boldly inquire if there may not be some other source from which we may draw the required element, some source where it may exist in concentrated form, requiring not to be condensed by wasteful compression in order to be available for admixture with our carbon. It is obvious that we cannot undertake to mix our carbonaceous fuel with air and handle, store, and utilize it in that form; but if oxygen can be obtained in concentrated, stable form, then we may hope to evolve a fuel containing this element in sufficient proportion to enable it to burn in our cylinders or combustion chambers wholly independent of air supply, and many of our most troublesome problems in power generation will be solved.

Perhaps we have now proceeded far enough with this discussion to venture to mention gunpowder and other "explosives" as illustrations of the possibility of actually producing a fuel containing all the elements of combustion. Perhaps we may also venture the suggestion that gasoline, as vaporized and mingled with air in the cylinder of an explosion engine, is quite as much an "explosive" as blasting powder, and is in fact a higher explosive than some forms of slow-burning powder. This comparison is suggested merely to show the possibility of manufacturing a complete fuel substance capable of burning and generating controllable gaseous pressure without the admixture of air. Well-known facts of course, and so are all the facts with which this discussion has dealt and will deal, and it is presumably because these facts are so well-known that they and the conclusions deducible from them have so long been slighted.

If we can make, compound, or prepare a fuel substance carrying its own oxygen, why do we undertake to employ an incomplete, volatile, and expensive substance like gasoline, and then reach out and endeavor to capture and utilize for its combustion the gaseous oxygen of the atmosphere? The reasons are probably, first, that we have not "reflected" upon this phase of the matter, and second, the oil refineries have had gasoline to sell. And as matters go in the field of power engineering, these are apparently all-sufficient reasons. The time has arrived, however, when all this should be changed.

When the power engineer undertakes to furnish motive power to meet the exacting requirements of modern scientific enterprises he is bound to consider broadly and in detail every phase of the science

of harnessing natural forces. He must consider and weigh the merits of all available forms of mechanisms, materials, and fuels. It will be no longer sufficient to apply himself to devise cunning improvements upon the established and accepted forms of motors, accepting without thought or question the materials and fuels thrust upon him by interested manufacturers. He will demand that the materials entering into the construction of his mechanisms be of the composition representing the latest word and wisdom of metallurgical research, and he will also demand that the fuel substances furnished him from which to evolve the motive agent which breathes life into his mechanical creations shall have received the same intelligent scientific attention, and shall have been produced or compounded with an eye single to the fulfilling of the requisites of a fuel perfectly adapted to power uses. He will no longer be content to exercise a hard choice between several variously unsuitable casual products of the oil refinery, of varying and uncertain composition, only partially prepared for his use and owing their existence on the market to chance causes entirely unrelated to his imperative necessities. He will require that his fuel be especially prepared to meet the requirements of each of his various applications of fuel for power. He will require a special composition for his airship motors, another particularly suited to his marine-propulsion mechanisms, and still others, perhaps of less refined and exacting composition, for the use of motors for general purposes.

All this must follow as a result of the application to the important question of fuel for power of a modicum of the scientific intelligence and resources now lavished upon other fields of production and manufacture.

The foregoing reference to the fact that the so-called "explosives" employed in ordinance and blasting operations are in the nature of complete combustibles indicates the direction which this development may take. It is probably not feasible actually to employ for power purposes any of the substances referred to, though it is certainly quite possible to operate a motor with a slow-burning gunpowder, as has many times been demonstrated, just as it is quite possible to hurl a projectile through the air with the expansive energy of a charge of gasoline and air. But this is simply because those substances have been prepared with ends in view quite different from the operating of engines. If the same scientific attention had been given to the development of a "self-contained" fuel for power purposes as has been expended upon the production of fuels for the

projecting of death-dealing war-missiles through space, we should have emerged long since from the present highly unscientific state characterizing this vastly more important fundamental industry of peace, the production of useful power.

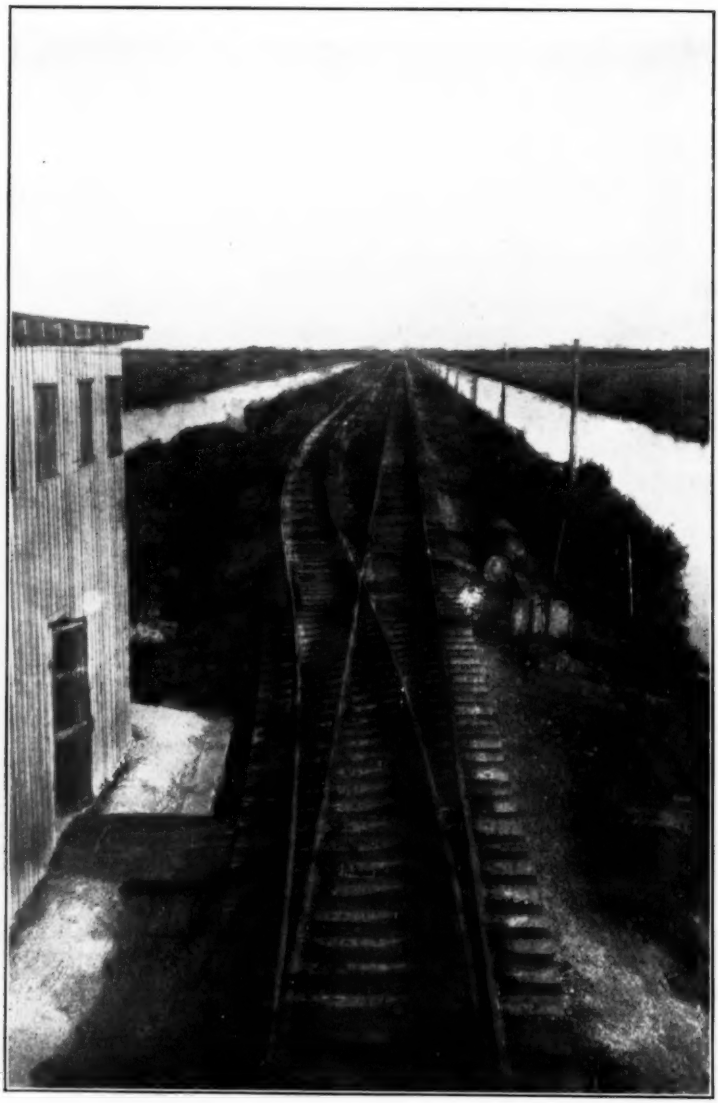
The two principal elements of a complete self-contained combustible are on every hand available, the carbon in the various grades of coal and hydrocarbon oils and the oxygen in the numberless oxides and nitrates of the earth. It only remains to bring the elements together in proper form and proportion to constitute a self-contained fuel, adapted by physical form and composition to use in our motors as a perfect fuel substance, requiring only to be ignited to produce the desired complete combustion of its elements.

The principal practical problems involved in the commercial production of such a fuel as is suggested by the foregoing are largely those arising from the questions, first, of stability or safety, since a fuel containing all the elements for complete combustion in its own volume is necessarily inherently liable to accidental combustion and, second, of cost of production.

That existing "explosive" or self-contained fuels might theoretically be employed for power in a suitably designed motor there can be no doubt. The problem is simply to modify both the fuel and the motor so as to make that which is theoretically possible practically attainable.

The fuel must be safe and the motor must be capable of utilizing it. Also the fuel must be producable at a cost comparable on a basis of dollar efficiency with existing methods of developing power.

The accomplishment of these ends is a work requiring the joint effort and intelligent co-operation of the power engineer and the physical chemist. When these two potential forces can be brought into earnest collaboration and their energies focussed upon this vitally important problem of fuel for power, then and only then can we hope to see the generation of power, that most important branch of applied science, placed upon a truly scientific and economic basis and an intelligently ordered system for the conservation of our fuel resources and the application of mechanical power to the work of the world supplant the existing "chaos of confusion and waste."



AN EMBANKMENT OF MARINE MARL.

IMPORTANCE OF THE RAILWAY TO KEY WEST.

By William Mayo Venable.

"IT is a wonderful feat of engineering, but I do not see how it can ever pay interest on the investment." This remark, referring to the "railroad across the ocean," officially, the Key West Extension of the Florida East Coast Railway, has become familiar to the ears of members of the construction organization. The opinion is shared by some of the employees of the road, as well as by many travelers who have visited the work, and by persons who have heard its more difficult features described. The recent suspension of building operations beyond Knights Key Dock, which is forty miles east of Key West, occasioned renewed speculation as to whether the road will ever be carried to its Key West terminus; and not a few believe that further extension would be a waste of money.

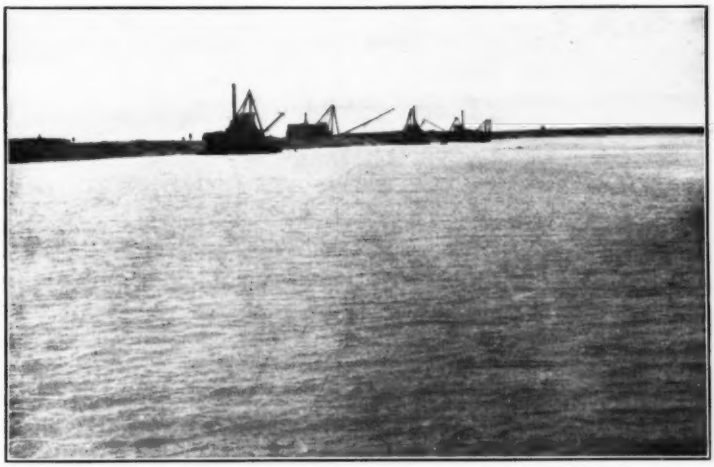
Henry M. Flagler, it is said, is building the line for the sake of fame, not utility; he desires to reach Key West merely for completeness, because that city is the southernmost point in Florida as well as in the United States; the extension is to be a monument to his memory. Undoubtedly those who direct enterprises of world-wide importance desire to impress themselves upon the world in works that will last; but a worthy fame must be connected with worthy works, and it is absurd to think that Mr. Flagler would construct this railway if he thought that it is to be known to future generations as "Flagler's Folly." To him it is an enterprise worthy of the capital required to create it. Fame of having built an expensive work for an unimportant or unproductive use could have no appeal to the mind of a man trained in the severe principles of business economics. Unless Mr. Flagler is mistaken in his appraisement of the possibilities of this enterprise; others ought to be able to see in it a utility that will justify its cost; in business terms this means a capability of returning interest upon the investment, to the owner, or, if the object sought is a national or philanthropic benefit, to his beneficiaries, within a reasonable time after the completion of the project.

The increase in traffic that may be expected to result from the line to Key West may be considered conveniently under two categories:

first, business similar to that which is already done by the railway with its present termini; and second, business of a new character, arising from the new port and terminal facilities. Before the increase in traffic is considered, the present business of the road and the manner in which it has been developed require brief review.

The growth of the Florida East Coast Railway from point to point southward along the Atlantic seaboard until it reached Miami was accomplished without bankrupting its owner, by means of a wise system of managing the railway in connection with other industries, so that paying traffic over each new section was established in a remarkably short time. From the beginning, the road served the purpose of affording access to the hotels of the Florida East Coast Hotel Company, whither winter visitors thronged year after year in ever increasing multitudes, as well as that of carrying freight and passengers for the communities that became established as soon as transportation was provided. In connection with the hotel company the road was a necessity, and it could be operated at a loss if necessary for a few years, on any new section, in order to make a profitable business possible at the hotels, which were owned by the same proprietor. Local freight business was developed as rapidly as possible as the road crept southward, by constantly bringing the possibilities of the country to the attention of all classes, including the tourists, and by fostering immigration. Successful methods of agriculture were stimulated by rendering limited financial assistance to a few of the most capable and progressive farmers, who were willing to adopt scientific methods, and who were so successful that their example became an object lesson which the less progressive were willing to follow. The crops raised, though requiring large expenditure per acre, brought high prices in the northern markets; and the freight rates were such as to put the road upon a self-sustaining basis long before the capacity of the country for producing freight was reached. Year after year the railway extended a branch down the coast, establishing a town at each new terminus, as a strawberry plant puts forth runners and establishes new plants, each new terminus being supported by the parent line until it was capable of drawing its own support from the soil, until Miami was reached. Here a dock was built, whence the Peninsular and Occidental Steamship Company operated steamers to Nassau, Key West, and Havana, and foreign trade began to loom over the horizon—another and a larger world to conquer. It is this step, from a road bringing the East Coast of Florida into communication with the northern parts of the United States, to a road using the Florida Peninsula as a route to carry trade originating outside of

Florida to destinations also outside of that State, that makes the Key West extension quite a different kind of project from any previous extension that was made in the course of the growth to Miami. Within the State the freight consisted of turpentine, lumber, subtropical fruits and winter vegetables, shipped north; and fertilizers, machinery, staple food articles, and manufactured products necessary for civilization, shipped south. The peculiarities of the climate and soil of the territory make the handling of a large volume of freight in proportion to the population more necessary than in a country where all the natural products required by a complex civilization are native, and the soil is highly productive without the use of commercial fertilizers. Briefly outlined, the business of the railway has expanded consecutively in the following named directions:—carrying passengers to and from winter resorts, exporting lumber, turpentine and other products of an undeveloped territory, exporting agricultural products for the northern winter markets, the necessary importing of fertilizers and equipment for carrying on the industry, as well as the larger part of the food products and all of the manufactured products required by the local population, and finally conveying passengers and freight through the State on their way to foreign lands.



DREDGES BUILDING EMBANKMENT IN SHALLOW WATER.

The character of the country on the line of the extension from Miami to Key West is quite different from that of the other portions of the road, and it may be described briefly. The distance is 150 miles. Of this the first 30 miles, starting from Miami, runs over a

rocky ridge known as the Biscayne Pineland, on the northwest of which lie the Everglades, and on the southeast Biscayne Bay. This part of Florida is especially suitable for raising grape fruit, but is well adapted for the culture of other fruits and vegetables, and it is being developed rapidly, already producing enough freight to justify the extension through it. A large amount of lumber is obtained in this region. The last town on the ridge is Homestead, after leaving which the road traverses the Everglades for a distance of 30 miles of unproductive territory. Across the glades, which are usually cov-

ROCK FILL AT PULL-AND-BE-DAMNED CREEK.

ered with water a few inches or a few feet in depth, the roadbed is constructed on an embankment, with a canal on each side. The view from the train extends over a broad expanse of sawgrass meadows, interspersed with small "hammocks" or islands of tropical trees and shrubs, which close the horizon on all sides. As the railroad approaches the bay the water becomes salty; mangrove trees and bushes growing in the shallow water and forming islands of verdure take the place of the meadows. Upon these islands of greenery the roadbed runs from the mainland to the solid keys of coral rock that encircle the lower end of the Floridan peninsula, entering at a point near the middle of Key Largo, the largest of the keys, having a length of 27 miles. Key Largo and the nearest keys to the southwest of it, Long Island, Windley's Island, and Upper Matecumbe, are susceptible of cultivation, producing limes, grape fruit, oranges, pine-

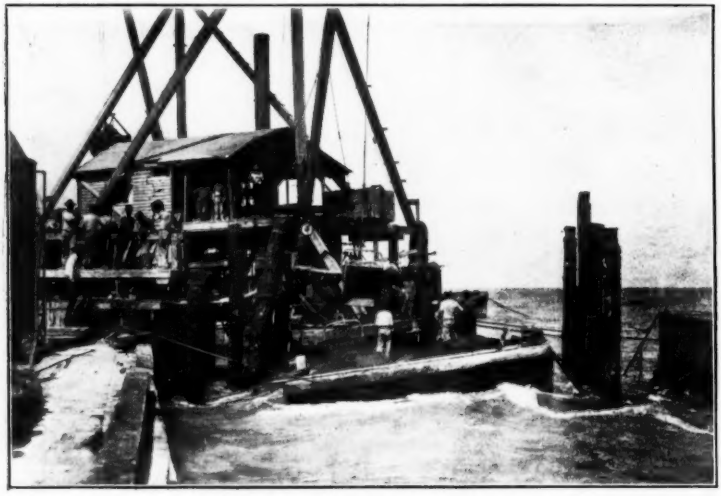
apples, bananas, guavas and other fruits. Possible shipments from them are worthy of consideration, but there is no prospect that they will produce sufficient local freight to justify the expense of the extension from Homestead. Continuing to the southwest across Lower Matecumbe, Long Key, Key Vaccas, Knight's Key, Bahia Honda, several smaller spots of land and many long stretches of water, to Big Pine Key, there is no land high enough above tidewater to be of importance agriculturally, although there are several spots where beautiful retreats for winter residents might be developed. So inhospitable is this stretch of almost 50 miles that no homes existed in it when the railway extension was commenced, but there were a few dilapidated relics of previous attempts at settlement, and a few negroes were accustomed to encamp on Key Vaccas during the winter season.

APPROACH TO THE LONG KEY VIADUCT IN PROCESS OF CONSTRUCTION.

From Big Pine Key to Key West the keys afford better chances for cultivation, and there are a number of homes scattered throughout this region; but there is nothing of sufficient importance to be any inducement toward building the railway to them.

The physical difficulties and the expense of building the road from Miami to Key West are distributed very unevenly over the route. The portion from Miami to Homestead offered no special obstacles. Across the glades, dredges working on each side of the line made an embankment of half a dozen cubic yards per running foot at a

very low cost, and the work was difficult only because the marine marl, which was the material handled, dried out but slowly, and the bank had to be raised by stages, instead of by a single operation of the dredges. The cross section of the embankment became greater as the exposure to wave action increased, and in many localities, especially where the line crossed from the mainland to the keys, the material to be used for the embankment was so soft that great quantities were necessary, on account of the slope it assumed when placed in the fill. Occasionally the only material available at the site was the fiber of mangrove roots, which had accumulated in the water for a depth of many feet. When dredged into a bank this dried out and became inflammable, so that it required a covering of broken stone to protect it from fire, as well as to make it steady enough for track.



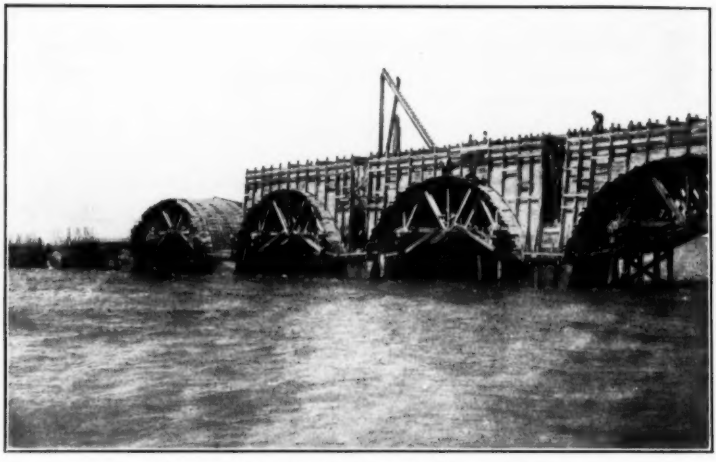
A CONCRETING BARGE AT WORK.

The grade work on the keys was done by day labor, either with wheelbarrow and shovel or with carts, as was most convenient at each station. Where the embankments were very large and the conditions favorable, excavating machines operating orange-peel buckets were employed. The material available for embankments on the keys was sometimes sand, sometimes marl, and sometimes coral rock, and whatever was at hand was used, the sides of the banks being riprapped afterwards if necessary. On the keys the top of the grade was from 6 to 10 feet above tidewater, according to the exposure. The embankments across the openings between the keys were difficult and costly,

as the sections were large and the exposure to wave action and to tidal wash severe, especially during construction before the riprap was in place. At the approach to the Long Key viaduct the section of the embankment is about 2,000 square feet, and the top of the grade 24 feet above the water; at Pull-and-be-Damned Creek the section is about the same, but the grade is only 8 feet above water, the bulk of the material going to close the deep creek, in which a current due to a head of 2 feet of tide oscillated twice a day.

FINISHED PIERS OF THE LONG KEY VIADUCT.

The first of the viaducts is located 90 miles from Miami, southwest of Long Key. It is 2 miles long, and carries the track 31 feet above mean low water. A series of 180 arches of reinforced concrete, built to withstand wave action as well as to bear the weight of trains, it is a substantial and expensive structure. Between the end of it and Knight's Key, about 18 miles, the road runs on embankments in shallow water protected from the ocean by interposing keys, or upon the keys themselves; but from Knight's Key to Big Pine Key, a distance of 13 miles, the most expensive and difficult portion of the work of construction is concentrated. Three viaducts with an aggregate length of 4 miles will be required on this stretch, the deepest water to be crossed being more than 30 feet, while practically all the embankments are to be subjected to severe wave action. From Big Pine Key to Key West the exposure to currents and to waves is not bad, and most of this part of the road is practically ready for track, and awaiting only the connecting link to Knight's Key.

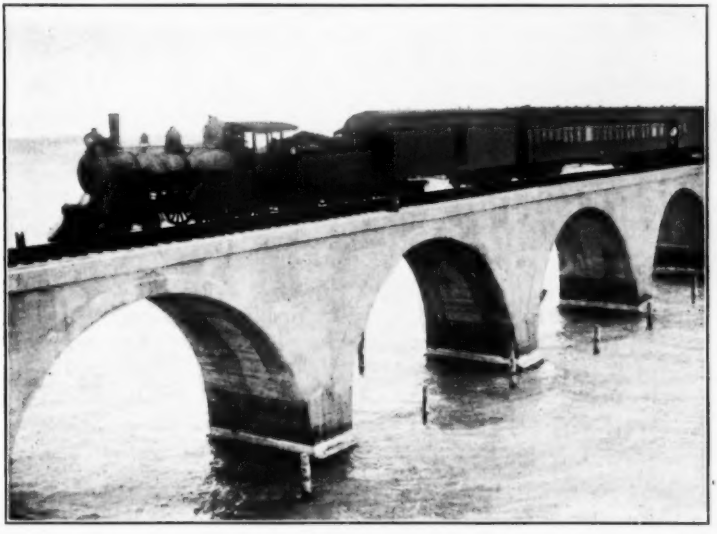


ARCH FORM WORK ON THE LONG KEY VIADUCT.

On February 6, 1908, the road was opened for business as far as Knight's Key Dock, although a very large amount of work still remained to be done to make the embankments between the keys permanent. Before that date all construction work southwest of Knight's Key was suspended, and no steps taken that indicated a resumption of work south of that point at a definite time to come. Work on the terminal dock at Key West had been suspended a few months earlier, the occasion being a disagreement with the United States Navy Department about the right of the railway to dredge certain material in the harbor for use in reclaiming land for the railway terminal. Knight's Key dock was built in a channel near to Knight's Key for the purpose of receiving materials for the construction of the viaducts, this being the most convenient place at which gravel, broken stone, and cement brought from afar could be transferred from vessels large enough to navigate the ocean safely, to barges of shallow draught for conveying it to the sites where the bridges were to be constructed. Vessels drawing 19 feet of water can reach Knight's Key dock from the Atlantic, although Miami harbor cannot be reached by vessels drawing more than 14 or 15 feet. From Knight's Key to Havana is but a trifle greater distance than from Key West to Havana, and as soon as trains were run to Knight's Key the P. & O. Steamship Company discontinued its service of three ships a week from Miami to Havana via Key West, and substituted therefor a daily ship from Knight's Key to Havana and a separate ship between Knight's Key and Key West, so that Key West is not now on the

line of travel from Miami to Havana. However bad this arrangement may be for Key West, it would seem to be as serviceable to the railway as a terminus at Key West, unless it can be shown that there are advantages in the port at Key West that will bring to the railway business that cannot be diverted to Knight's Key. It is undoubtedly true that by making Knight's Key its terminal this year, the railway was able to transact practically as much business as it was able to handle with the road in its uncompleted condition and the necessity of continuing with a certain amount of construction work. The passenger business certainly did not suffer, for the travel was little short of phenomenal. What advantages, then, can Key West offer, which will justify the expenditure of the millions of dollars necessary to reach it and to construct a terminal?

Of the larger islands of the Florida Keys, Key West is the most western and southern, although not the most western or southern of all islands in the group, which extends about twenty miles west of Key West. It is not really large, its length being four miles and its width a mile. The surrounding water is shallow, except at the northwestern corner of the key, where a deep passage known as "Man of War Harbor" comes close to the shore. This channel is easy to enter from the Strait of Florida, as the deep water between the keys and Cuba is named, Havana being less than 100 miles distant. To the



THE COMPLETED VIADUCT.

east and the northeast lie most of the Florida Keys and the Bay of Florida. Cape Sable, the most southern point on the main land, is 60 miles away, surrounded by shallow water. Tampa is about 230 miles to the north; Pensacola over 500, New Orleans more than 600, and Galveston more than 850 miles distant. Key West is on the line of ship travel between all points on the Gulf of Mexico, Yucatan, and Honduras and the eastern coast of the United States. Vessels from Europe to Mexico or to Yucatan pass within sight of it. Those from Europe to Central America have choice of passing Key West or of going to the south of Cuba.

Its convenient location at the gate of the Gulf of Mexico, and opposite to Havana, did not make it a place of great importance in early days, because of its isolation from the continent. While a place where a stop could conveniently be made, it possessed nothing to induce a ship to stop; but in spite of its isolation it has now grown to be a town of more than 17,000 inhabitants, and it is regarded by its natives as the most desirable place in the world to dwell in. When Florida became a part of the United States, Key West increased in importance for both legitimate and illegitimate industries. It had a value as a naval base and as a port of refuge for vessels not over-anxious to obey the Spanish laws. Many Cubans settled in Key West, and Spanish is still as much spoken there as English. Residing where the means of making a livelihood were limited, where agriculture could not be carried on to any great extent, the native of Key West was a good fisherman, a sponger, and a wrecker; but he was very likely to be a cigar maker also, and when times afforded such occupation, a blockade runner, a smuggler, or a revenue officer. Of late years wrecking has not given much support to the people in this part of the world, on account of the scarcity of wrecks. The light-house service along the coast is effective, and few vessels are lost on the reef. The most important industry of the island now is the manufacture of cigars of Cuban tobacco. The city has a coastwise and insular trade that is carried on by small sailing vessels, which usually spend the winter months fishing for Spanish mackerel, which are shipped north from Miami by express. Steamships of a number of lines stop at Key West occasionally, and some regularly during the winter, and the naval station and the army post assist in furnishing employment for the people of the city. During the past few years the construction work on the railway terminal and the grade approaching the city brought many persons to Key West and contributed to the business there; but the cessation of this work and the diverting of through travel to Havana accentuated the hard times that the town

is suffering owing to the depression in the cigar industry, which has resulted from the general financial depression throughout the United States. A few years ago there was considerable opposition in Key West to the coming of the railway, many persons feeling that this innovation would destroy their isolation, in which they took real pride and comfort, and to which they even ascribed the prosperity of the town. But when the railway came to be regarded as a certainty the people began to speculate upon its results, and real estate went soaring. When doubt was again entertained as to the certainty of the railway reaching the island, and when work of construction was suspended without definite announcement that it will be resumed, the city was plunged into consternation. That the city would profit by the advent of the railroad now needs no argument to convince the most conservative citizen. But that the railway will secure at Key West sufficient business to justify completing the road to Key West is not so clear.

TRESTLE APPROACHING KNIGHT'S KEY DOCK.

The disadvantages of Knight's Key dock over Key West are these. Access to it can be had by ships drawing only 19 feet of water, while vessels into Key West may draw 30 feet or more. Key West has an area sufficient to permit the building of a large sized town, while Knight's Key contains less than half a square mile of land, and the dock is half a mile from the key, so that there would not be room for the establishing of any industry at the terminus, and

the dock can be only a point of transfer of goods from the trains to the ships and from ships to trains. Key West is already a town of considerable population, a naval and a military base, a coaling station, and a port where vessels of many lines are accustomed to go occasionally, and it is located a few miles nearer to the gulf, and consequently to the Panama Canal. The importance of these advantages of the Key West terminus become apparent upon consideration of the nature of the business to be anticipated by the railway when it has established its terminal.

WATER-SUPPLY STATION.

That business in which the Florida East Coast Railway is expert, namely the carrying of passengers from northern States to southern winter resorts, will doubtless continue to increase for many years to come, for this is stimulated by the growing interest on the part of the American people, especially the business men, in the affairs of South America and the West Indies. The travel over the East Coast Railway during the season now closing is said to have been one third larger than during any previous season. The shorter the distance that must be travelled by water, the more readily will a great many persons undertake such journeys. The Key West terminus will afford opportunity of making connection with steamers bound for any part of the world, not merely those operated over short distances. The terminal dock at Key West is planned to receive alongside of it vessels drawing 30 feet of water.

The advantage of location at the entrance to the Gulf of Mexico is great enough to make Key West a desirable terminus for a railway communicating with the interior of the United States. But this advantage will be greatly increased when the Panama Canal is opened for international travel. The master of a vessel from Europe, desiring to discharge a small part of his cargo for delivery into the interior of the United States and to proceed with the rest through the canal to Asia or to the west coast of South America, will naturally prefer to run as little out of his course to Panama as possible. In this, Key West harbor has a great advantage. Running in to Pensacola or to New Orleans *en route* for Panama would make the sailing distance 850 miles longer than running in to Key West; and a similar diversion to Galveston would lengthen the voyage 1,300 miles. Such an additional distance with a big ship is an important matter, and it would be preferable to make a much longer haul by rail if the portion of the cargo to be discharged in the United States were small. The shorter distance from Key West to the Canal and to points in the West Indies and South America will undoubtedly lead to the concentration of several lines of fast steamers to such ports, carrying the bulk of the passengers, the mail, and the express business, on account of the faster schedule.

CAMP IN A COCOANUT GROVE.

From time to time there have been rumors, doubtless not wholly without foundation, that the Florida East Coast Railway will arrange to operate a ferry from Key West to Havana, upon which railway cars will be transferred bodily, and conveyed on Cuban railways to various points in Cuba. The distance across the strait is less than a hundred miles, and there is nothing in the proposition that is not entirely practicable from an engineering point of view. The effect of refrigerator car service both ways between Chicago and New York on the one hand and the interior of Cuba on the other at all seasons of the year can be imagined; and it would be interesting for the northern farmer to ship fresh vegetables to Cuba in the summer time, and to eat fresh vegetables from Cuba in the winter; but to depart less from the probabilities of the next few years, such car service if established now would be able to carry certain fruits and vegetables through at a profit from the south to the north, and doubtless carry beef the other way. The freight business between the interior of the United States and the interior of Cuba, of which there is a large amount, will tend to go all the way by rail as soon as such a transfer is possible. It is difficult to see how water transportation can compete with a rail haul of this kind, even for such products as sugar, when the point of destination is in the interior of the country.

After the Florida East Coast Railway has established its terminal dock at Key West, and after the Panama Canal has been opened for traffic, the quantity of freight hauled over the East Coast Railway will probably be fixed not by the competition of other means of transportation, but by the physical capacity of the road. This will most likely come about in spite of higher freight rates by rail, for on account of the high cost of construction of the road higher rates are permitted by law over the Extension than on other lines, and the legal fare that may be charged for a passenger is fixed in the charter of the road at four cents per mile, during the first fifteen years of operation.

Far from being known as "Flagler's Folly," this road will be a monument to its builder indicative of his far-sightedness and his willingness to devote his resources to an enterprise of world-wide importance, even though he undertakes it late in a life which has, however, been devoted to the building up of industries to which this is the natural sequel. His undertaking it indicates not a lessening of intellectual vigor, or a weakening of the judgment, as some would have us believe, but the ability to sustain the burden of a great project, for the sake of having it accomplished, with the belief that the work will be justified.

SPECIAL ALLOY STEELS AND THEIR MECHANICAL APPLICATIONS.

By Léon Guillet.

In many fields of engineering, there has been a most interesting evolution of improvement in materials, design, and methods through the reciprocal effort of the constructor and the metallurgist. In no case, probably, has that advance gone further, in recent years, than in the higher grades of machinery. The combustion motor, the motor car, the aeroplane, and by no means least, the modern tool, have stimulated investigation and led to discovery of new and most useful alloys. M. Guillet is known all over the world as a foremost specialist and authority in the subject, and his summary of conclusions so far established will prove a valuable synopsis of the state of the art for all interested in the new alloy steels and their properties.—THE EDITORS.

THE utilization of special steels—that is to say, of alloys of iron with carbon and one or several other elements—may be considered from different points of view. First, we might seek to increase the safety of machine parts. To secure that we would not diminish the section of pieces calculated with the ordinary coefficients for common steel; and as these coefficients are higher in the special steels the strength would naturally be increased.

Again, it might be our purpose (and this question is particularly interesting in aviation and in automobile work) to preserve the same coefficients as we have been applying to ordinary steel, and then we should be enabled to reduce the section, or in other words, to diminish the weight, and thus to make the machinery lighter.

Finally, our search might be for steels with altogether peculiar properties, as, for example, non-fragility after hardening, as in some nickel-steel alloys, or a predetermined coefficient of expansion, as in other alloys in which the content of nickel is high.

In any study of the alloy steels the division generally adopted is based on classification according to the foreign substance added. In this short study preference is given to investigating what we may demand from the different special steels, with reference to their employment in mechanical construction. We may seek to obtain:

1.—High resistance to shock.

2.—The highest possible elastic limit.

3.—Resistance to abrasion.

4.—More generally, simultaneous fulfilment of several of these requirements.

Metal giving higher resistance to shock, according to modern theories, ought to give good results under test upon the nicked bar. Steels best fulfilling this condition are those with a high percentage of nickel and of manganese, which have a special structure and in which the iron is in the allotropic form defined as γ iron by M. Osmond. These steels will easily give 40 to 50 kilogrammetres in the test on the nicked bar. They have, however, several disadvantages; their elastic limit is relatively low if the metal is not cold-hammered (20 to 25 kilogrammes) and they are extremely hard to work; some of them indeed can not be worked except by grinding.

At the present time they have important applications. Foremost, they are employed for the construction of valves for petrol motors, the steel commonly used showing carbon 0.25 to 0.30 per cent and nickel* 32 per cent.

A steel is also used with the same carbon and nickel contents, but with 2 per cent of chromium in addition; this gives a much greater hardness. Further, the steels of γ iron are much used for parts of railway track which are subject to heavy blows, as, for example, frogs. They are no longer used, at least in France, for shafts.

Other kinds of steel may also be chosen for high shock resistance, but it is necessary above all that these alloys shall be low in carbon. Nickel steels are particularly to be recommended; they may contain up to 0.30 per cent of carbon and 5 to 6 per cent of nickel. With a higher proportion of nickel they possess of themselves the structure of tempered steels (martensite) and become extremely difficult to work.

The other elements—manganese, chromium, tungsten and molybdenum—are rather injurious. However, it might often be of interest to add chromium, especially, to nickel steel, without reducing its shock resistance.

There is, however, one element which is particularly interesting in this connection. This is vanadium. Vanadium imparts to steel two qualities which are very definite. It plays the *rôle* of an anti-crystallizer—that is to say, it forces the iron to form much finer crystallization than would occur in its absence; second, it gives to the alloy a considerable tempering quality without in any way injuring its resistance to shock—at least when the vanadium is in small quantity. Indeed, it must be remembered that this element (one of the most useful in metallurgy, according to my opinion) should be administered in homeopathic doses. Not more than 0.5 per cent of vanadium should

* Only the important elements are given. There are never more than traces of sulphur and phosphorus.

be added; 0.2 is generally sufficient and a "dose" of more than 0.7 per cent is extremely injurious. Let us look further at examples showing well the influence of this valuable element.

1.—Simple vanadium steel. Composition, carbon, 0.144; vanadium, 0.290; managenese, 0.125; silicon, 0.105. Annealed at 850 degrees it gave:

R = 44; E = 30; A per cent = 24; Σ = 62.5; shock = 30.

Quenched at 850 degrees it gave:

R = 55; E = 50; A per cent = 23; Σ = 67; shock = 10.

R signifies the breaking load in kilogrammes per square millimetre. E is the elastic limit in kilogrammes per square metre. A per cent signifies elongation after rupture, referred to 100 millimetres of initial length. Σ is reduction of area or "choke" of the test bar—that is to say, the ratio

$$S - s \times 100 \div S,$$

S being the initial section and s the reduced section after rupture. Shock signifies the number of kilogrammetres obtained on a nicked test bar of the Mesnager type. The dimensions of this bar are 60 millimetres long, 10 millimetres wide and 10 millimetres deep. The nick is 2 by 2 millimetres, rounded at the bottom. These symbols will be employed throughout the article with the same meaning. For convenience it may be remembered that the figures here given in kilogrammes per square millimetre multiplied by 1422.3 will give the equivalents in pounds per square inch.

2.—Nickel-vanadium steel. Composition, carbon, 0.261; nickel, 2.32; vanadium, 0.35; manganese, 0.45; silicon, 0.539. Annealed at 850 degrees it gave:

R = 66.3; E = 55.2; A per cent = 21.5; Σ = 57.2; shock = 31.

Quenched at 850 degrees it gave:

R = 117.0; E = 97.0; A per cent = 8; Σ = 44.3; shock = 11.

Tempering power is considerably increased by the addition of vanadium. To summarize, we may note that for parts subject to shock:

a. In special cases where a low elastic limit is not dangerous, where difficulty of working is not a serious objection, and where price does not enter as a very important factor, steels with a high nickel or manganese content may be used.

b. In more ordinary cases, steels with a small proportion of nickel are very interesting and their mechanical properties may be remarkably increased by the addition of chromium and of vanadium. We shall return to this later. Still another case at least as important as

the preceding, is that in which the maximum of strength and of elastic limit are sought. At the same time it is generally desirable to avoid too great brittleness. The problem may be approached in various ways. Many shops which have little or poor equipment for hardening or heat treatment, seek a metal which in the condition in which it is delivered to them combines these resistance qualities with comparative ease of machine-tool working. Other shops, on the contrary, more modern in their equipment, seek rather the quintessence of desirable qualities in all the metallurgical products which are offered to them, and care little how complex may be the heat treatment to which the parts should be subjected. From these points of view, therefore, we may class the high-resistance steels in two categories—those used without treatment or with only very simple treatment, and those which must be treated before they are used. The applications for steels which can be used without treatment are relatively few, because the mechanical constants of these alloys are never extremely high, at least until the percentage of alloy rises so high that the structure of the mass becomes the same as that found in tempered steels (that is to say, martensitic) and we then have to deal with a material which can not be worked except with great difficulty. What limits, then, do we actually find in the present state of the industrial manufacture of special steels, so far as concerns the obtaining of determined mechanical properties in untempered metal? Let us eliminate at the outset the martensitic steels which are too difficult to work. If, then, we examine simple steels—those containing only one special element—we shall find that among nickel steels those giving the highest results are the alloys containing 5 to 6 per cent of nickel and 0.25 to 0.35 carbon. They give:

R = 70 to 80; E = 60 to 70; A per cent = 25 to 20; Σ = 60 to 70; shock = 25 to 35.

It is plainly possible to obtain nickel steels with much higher breaking strength and elastic limits; for this it is sufficient to increase the carbon and to decrease the nickel. (If the carbon be increased while the nickel content is maintained constant, a martensitic steel will be obtained). But it is well to remember that this principle applies in some degree throughout the metallurgy of special steels—that is, that when carbon is increased brittleness is also increased to such an extent that the steel rapidly loses its suitability for most of its applications. We shall see later on the important restrictions which must be noted in this regard.

A French firm has recently put out certain nickel steels high in carbon. The analyses and characteristics of two of these types are:

a. Carbon, 0.862; nickel, 0.88; chromium, 0.85; manganese, 0.23. Annealed at 750 degrees, with no tempering, it gave:

R = 97; E = 51.3; A per cent = 11; Σ = 23.8; shock = 3.

b. Carbon, 0.771; nickel, 1.13; manganese, 0.32. Under the same conditions this showed:

R = 108.3; E = 61.5; A per cent = 10; Σ = 19.3; shock = 3.

The brittleness of these steels will be clearly observed. It is to be noted that the breaking strength is determined in all cases in the direction of the lamination. It would certainly be lower still if taken transversely to lamination. It is therefore necessary when a high breaking strength, a high elastic limit, and resistance to shock are simultaneously required, that the carbon content should not be raised. My own opinion is that it ought not to exceed 0.40 per cent and that it would often be better even not to reach this limit. However, the case is quite different, as we shall see later, when the question of resistance to abrasion must be taken into account.

If we turn now to other species of simple steels, we shall find but little of interest. Those alloyed with manganese, chromium, tungsten, and molybdenum are very far from exhibiting the interest which is found in nickel steel. They are much more brittle, and the increase in the breaking strength and the elastic limit is less marked. Vanadium steels are not important, in the annealed condition, though we shall find them highly so when tempered. Silicon steels—the only remaining type—are also of interest only after hardening. Before hardening they do, indeed, show rather high tensile strength (85 kilogrammes) and a high elastic limit (45 to 55 kilogrammes); the elongation is not bad (15 per cent); but these figures are obtained from steels carrying carbon also, which are extremely brittle.

If, now, we take up the study of the complex steels containing two or three elements, we are led at once to the consideration of products almost all of which contain nickel with one or several other constituents. The compounds which are at present of industrial importance are the nickel-chrome and certain nickel-vanadium steels. There are, however, also, certain chrome-vanadium steels which are interesting. These steels are almost all employed after treatment. Let us see what should be understood by "simple treatment" and the qualities which the special steels must possess to be susceptible to it.

A simple treatment evidently should be one which does not require any complex manipulation, and one in which the temperatures need not be so accurately attained as to require instrumental measurement; in a word, it should be one which is practicable in any ordinary manu-

facturing plant. This treatment, designed to increase the tensile strength and elastic limit, is in fact primarily an operation of tempering. For simplicity it should not require any following drawing of the temper, nor the use of high-temperature measurements. The simplest of all these processes evidently consists simply in heating the metal followed by cooling in the air.

If we except the case of the rapid-cutting steels (a case easily explained, according to Le Chatelier and Osmond, by the difficult solubility of triple carbides of iron, chrome and tungsten in γ iron) we are led to the conclusion that the only steels which can really take a temper—that is to say, undergo transformation of their pearlite into martensite—are the pearlitic nickel steels which approach the limit of martensitic steels—for example, steels containing 0.30 per cent of carbon with 5 to 6 per cent nickel. Chromium and manganese increase further this property of air-hardening. Consider, for instance, the analysis of an air-hardening steel containing carbon 0.25, nickel 5.5, and chromium 1.0. After annealing with slow cooling this gave:

$$R = 70;\ E = 60;\ A \text{ per cent} = 25;\ \Sigma = 70;\ \text{shock} = 35.$$

After air-hardening at 800 degrees it gave:

$$R = 85;\ E = 70;\ A \text{ per cent} = 18;\ \Sigma = 55;\ \text{shock} = 25.$$

The disadvantage of these steels is in their cost, and further in that a very slight variation in composition often results in very large variations in their properties.

If air tempering is plainly the simplest, above all when the air-hardening temperature is not necessarily very high (as in the case of the rapid-cutting steels), hardening in a liquid may be regarded as a very easy manipulation if it does not involve subsequent reheating. Many steels may be used after hardening without reheating; others, on the contrary, must undergo reheating or, more exactly, annealing—that is to say, heating to a temperature lower than that of the point of transformation. Into this last category enter all the steels carrying high carbon—say, above the limit of 0.30 to 0.35. Below this, tempering in water is generally sufficient; above, reheating is requisite. At least this is true unless (and this point is vital) brittleness is not objectionable, or unless one uses for the cooling a liquid which reduces the activity of the operation—in other words, unless one employs a bath of such sort that the speed of cooling of the metal is reduced. Two examples may be given of modern steels which may be very simply treated:

1.—Nickel-vanadium steel, employed for shafts and also for de-

fensive armor-plates. It showed upon analysis carbon 0.25, nickel 6.0, vanadium 0.2. Annealed at 900 degres it gave:

R = 55 to 65; E = 40 to 45; A per cent = 25 to 20; shock = 20.

Quenched at 850 degrees in water without reheating it showed:

R = 110 to 140; E = 95 to 120; A per cent = 10 to 8; shock = 12.

2.—A steel susceptible of oil hardening without reheating and containing carbon 0.175, nickel 4.0, chromium 1.0. Annealed at 800 degrees it showed:

R = 97; E = 77; A per cent = 12; Σ = 40; shock = 3.

Quenched at 850 degrees in oil it gave:

R = 146; E = 129; A per cent = 9; Σ = 50; shock = 9.

The resistance to shock is thus sufficient for a large number of applications.

Let us now consider steels which must undergo complex treatment —that is to say, hardening followed by reheating. These necessitate special arrangements, both for the determination of temperature, and for the furnaces and heating baths. Baths of melted salts are to be recommended from every point of view, both for tempering and reheating. Steels of this class are many in number. We shall present the characteristics of the types most employed; but it should be remarked beforehand that in the analysis of the mechanical properties of metallurgical products, such as we have been making, there is another factor of which we have not yet spoken. This is the so-called endurance or Wohler test. Comparatively little attention has been given to these tests in France. In other countries, on the contrary, they have received a great deal of attention. English metallurgists have studied many types of steel from this point of view, and Ken Smith has shown that the chrome-vanadium steels are particularly interesting. Let us now take up the principal types of complex special steels employed when high breaking strength and elastic limit are required without attendant brittleness. These steels are in constant application in the French industries. Among them we find:

1.—The nickel steels whose characteristics we have already discussed.

1.—The nickel steels whose characteristics we have already dis-

We have already referred to a steel of this type containing carbon 0.25 to 0.30; nickel 5.0 to 6.0, chromium 0.5 to 1.0. Another steel of this class containing carbon 0.25 to 0.35, nickel 2.50 to 2.75, chromium 0.275 to 0.500, annealed gave:

R = 55 to 75; E = 35 to 50; A per cent = 15 to 25.

Quenched at 850 degrees in oil, and reheated at 300 degrees it gave:

R = 80 to 110; E = 60 to 100; A per cent = 8 to 12.

3.—Nickel-vanadium steels, which have been already described.

4.—Silicon steels of which the principal classes are, first, carbon 0.45 to 0.50, silicon 1.5 to 1.2, manganese 0.40 to 0.50; and, second, carbon 0.65 to 0.70, silicon 0.90 to 0.80, manganese 0.50 to 0.60. Both showed almost the same results, which in the case of the steel of the analysis first mentioned, annealed, were as follows:

R = 75 to 85; E = 46 to 50; A per cent = 18 to 15.

Quenched at 850 degrees and reheated at 500 degrees it gave:

R = 120 to 130; E = 100 to 110; A per cent = 12 to 15.

Let us now examine the case of a piece which must be exposed to abrasion or rubbing friction. This case, it should be observed, is extremely frequent; and even though the final result depends not only upon the substance which is exposed to abrasion, but equally upon the material which produces the abrasion, and the conditions under which the abrasion is produced (presence or absence of lubrication) nevertheless certain principles may be defined.

If it is desired to obtain a special steel of great hardness, using this word in its mineralogical sense, we must introduce two principal elements—carbon and chromium. But the former especially (as we have already said) causes at the same time brittleness. It must, therefore, be correctly proportioned. Further, many manufacturers prefer in a large number of cases to resort to case-hardening, which permits the production of an extreme degree of surface hardness secured by no other method, and which, if it is well done, leaves the body of the part very tough and with high resistance to shock.

Before entering upon the question of case-hardening, and exhibiting the important *rôle* which the special steels may play under this process, let us stop to consider the types which may best be employed to resist abrasion.

They must always possess a high degree of hardness; also they are employed after hardening, followed, if necessary, by reheating; but we must consider at the outset whether it is necessary further to avoid brittleness because the pieces must endure shock, or whether brittleness is non-important. Pieces which are subjected simultaneously to shock and to abrasion may be typified by automobile gears and particularly speed-change gears. They must be sufficiently hard to avoid wear; but on the other hand, the teeth must resist sudden shocks or blows, especially when a change of speed is made.

Many types of steel may be used for this result. First come the

nickel steels of greater or less complexity and with varying proportions of carbon. Next comes silicon steels, and finally the chrome-vanadium compounds. The principal kinds used at present in France show the composition and the properties expressed below.

1.—Nickel steels:

a. An alloy containing carbon 0.40 and nickel 5.75, air-hardened at 750 degrees, which gives:

R = 130; E = 110; A per cent = 8; Σ = 39; shock = 70.

b. A steel with carbon 0.35 to 0.40, and nickel 6.0 giving the following results:

	R	E	A per cent.	Σ	Shock.
Annealed	80	70	20	65	30
Air hardened at 850	125	110	11	53	19
Quenched in water without reheating	140	125	10	50	17

2.—The nickel-chrome steels which are most used are:

a. Carbon 0.25 to 0.35, nickel 2.50 to 2.75, chromium 0.275 to 0.50. Of this we have already spoken.

b. Carbon 0.45, nickel 2.50, chromium 0.50.

c. Carbon 0.60, nickel 2.50, chromium 0.50. It will be seen that these three types differ only in their carbon contents. They are all employed after hardening and reheating. The following results are given by the type *b*:

	R	E	A per cent.	Σ	Shock.
Annealed at 850 degrees	87	50	14	48	6
Hardened at 800 degrees and reheated to 500 degrees	134	122	7	48	11

It is noticeable that the resistance to shock is increased after tempering. Further, it may be remarked that in France 0.2 per cent to 0.3 per cent of vanadium is frequently added to steels of the preceding types, the hardening qualities being much augmented thereby. A fourth type used after air hardening is:

d. Carbon 0.35, nickel 5.0, chromium 1.0.

This steel is slightly martensitic and consequently is difficult to machine. After air-hardening it gives:

R = 143; E = 120; A per cent = 7; Σ = 38.7; shock = 6.5.

3.—Silicon steels, already discussed.

4.—Chrome-vanadium steels which are but little used in France. A typical composition is carbon 0.2 to 0.5, chromium 1.0, vanadium 0.8.

These special steels which we have just been considering are suitable for employment for various machine parts such as shafts, gears, axles, spindles, etc., which must resist wear and possess hardness with

a certain degree of toughness. There are other cases where brittleness is of little importance, and where it is necessary above all to obtain an intense surface-hardness. The best example which could be cited is that of a cage of a ball bearing. We need not fear that this part will be subjected to any more sudden blow than that to which the entire mechanism is subject. On the other hand, it must be extremely hard and the balls must not groove its surface. We need, therefore, consider but two factors—hardness which we can secure only after tempering, and the capacity for undergoing the hardening process without danger of cracks or flaws. All the special steels employed for the manufacture of balls and cages for ball bearings are chrome steels with percentages of chromium varying from 0.5 to 2.0 and carbon between 0.80 and 1.40.

We have already said that case-hardening is an operation commonly used to obtain great superficial hardness, which, without this process, we could not get even from special steels. We have remarked, also, that the new alloy steels have caused a great advance in the process of case-hardening, not perhaps in the surface produced, but at least in the final result of the operation so far as general mechanical properties are concerned. It is important to emphasize this point. When case-hardening of a piece is undertaken, the purpose is to obtain great hardness of the face with high shock-resistance or toughness of the body of the part. To this end, a steel is used containing but little carbon (less than 0.20 per cent) so that the prolonged heat of the cementation shall alter the mass composition as little as possible and that no brittleness after hardening shall result. On the other hand, it is necessary that the steel shall not contain more than 0.30 per cent of manganese, as otherwise the hardened face will be easily detached under the influence of blow or shock.

Case-hardening may be performed in two ways:

1.—The piece to be hardened may be kept in contact with the cementation material at a temperature of 850 degrees. The absorption of carbon is comparatively slow, but the interior mass, being only moderately heated, undergoes relatively little change; for, as is well-known, steel alters by heating directly in proportion as the heat is prolonged and especially as the temperature is high. The interior of the piece being but little changed, a single tempering at 750 degrees suffices to secure the surface desired.

2.—The case hardening may be prosecuted at a high temperature (1,000 degrees), but then the body of the piece is altered and its properties must be restored. To secure this result (the transformation point of extra-mild steel being about 800 to 850 degrees) it is

necessary to give a first tempering at 875 degrees, this being solely for the purpose of regenerating the quality of the interior mass; the transformation point of the high-carbon surface being about 720 to 750 degrees this preliminary tempering at 875 degrees does not secure sufficient hardness; the steel is easily attacked by the file. It is therefore necessary to give a second tempering at 750 degrees, which is essentially a hardening temper. For every reason this mode of operation is much to be preferred to the preceding.

These preliminary remarks seem necessary to an understanding of the considerable advantages possessed by certain special steels.

It must be noted, first, that certain elements promote case-hardening, while others retard it considerably. Nickel, silicon, and aluminum have been shown to belong in the second category, while tungsten, molybdenum and manganese belong in the first. The most interesting points, however, are the following:

When we case-harden a steel containing less than 0.20 of carbon and less than 0.30 of manganese, with more than 1 per cent of nickel (generally 2 per cent) there is no longer any need for two tempering processes to secure a tough body mass, even after cementation at 1,000 degrees; a single operation at 750 to 775 degrees will give simultaneously surface hardness and interior toughness. It may be noted further that, taking a steel with the same analysis as to carbon and manganese, but with nickel up to 6 per cent, under similar conditions, the pieces obtained will be very strong and free from brittleness.

On the other hand, if we take a steel containing 0.20 per cent of carbon and 7 per cent of nickel we shall find the same structure as in an ordinary annealed steel (pearlite); but a steel containing 0.80 of carbon and 7 per cent of nickel possesses the structure of tempered steel (martensite); if, therefore, by cementation of a steel of the former composition, we raise the proportion of carbon in the face to 0.80 per cent, we obtain by this simple process the same results which would be secured by cementation followed by tempering, and therewith secure the great advantage of avoiding the distortions of shape which tempering always occasions.

To sum up, special steels render most remarkable service in mechanical construction for various purposes; but it may be said also that mechanical construction, by a constantly more exacting demand and by requiring materials ever more and more remarkable in their properties, has gradually stimulated perfection of that branch of metallurgy which was first created by the need for armor plates; and that to this mechanical stimulus are due many of the latest and most noteworthy developments.

OBTAINING ACTUAL KNOWLEDGE OF THE COST OF PRODUCTION.

By F. E. Webner.

VI. COST RECORDS AS A CONSTITUENT PART OF THE GENERAL ACCOUNTING PLAN.

In the preceding instalments of his series, which began in our May issue, Mr. Webner has discussed the themes "What Constitutes a Knowledge of Costs"; "When and Where a Close Knowledge is Needed"; "The Profitable Use of Cost Comparisons"; "The Use and Abuse of Mechanical Aids in Cost Finding"; and "The Organization of a Cost Department." The paper presented this month concludes the series.—THE EDITORS.

THE logic or course of reasoning is not just clear, but the fact is patent, that a very large percentage of manufacturers who put their financial officers under heavy bonds for the faithful performance of the duties entrusted to them, and for the strict accounting for funds, will shut their eyes effectually to the oftentimes wanton waste of good material which goes on day after day within the range of the manager's vision. We may perhaps find that a manufacturing jeweler will guard his store of precious metal more closely than the manufacturer of machinery does his pig-iron pile, the reason obviously being that, to the petty thief, the intrinsic value per ounce of the former is more attractive than that of the latter. This comparison comes to my mind merely to emphasize the point that it is not the physical removal of goods through theft that is considered; that may be the least likely to cause any worry. For although a workman may overstep bounds occasionally, and with temporarily subdued conscience carry home a few nails to mend the cow shed, or studiously appropriate a little solder to mend Aunt Mary's wash boiler; or even yet, some of the younger element whose ideas of honor have not been cultivated to anything like dizzy heights, might, by cunning conniving, become able to lay thieving hands on brass in one form or another, a good watchman can detect such physical removals of stolen property, and a good watchman in a bank can detect the unlawful physical removal of money in bulk there, but in neither case is the greatest likelihood of loss; on the contrary, the loss most to be feared is that which can take place and often does take place right under the manager's supervision—losses which can be

detected only by good accounting methods properly and faithfully carried out.

The cashier's accounts can be checked and any discrepancies located by means of the checking process; disinterested auditors are now widely used for such checking process. If men will not be honest on principle they frequently will as a matter of good policy. It may be surprising to some to know that in many modern plants material is almost as closely checked as cash, and one purpose of this article is to impress on the reader's mind the fact that many more plants sorely need the means of accomplishing such a check. Spoiled work is one important leak which, if not so surrounded with safeguards as to detect it and show it up on the individual's record, will run into money; it frequently is not so much the intrinsic value of the iron as the cost of the workmanship already put on it, and where a plant has not a cost system this element of cost is frequently lost sight of entirely. One large plant in my knowledge keeps spoiled work at the minimum by giving a lay-off to every one who makes mistakes up to a certain amount in cost; one mistake may bring the lay-off, or it may take the aggregate of several smaller items. Another important leak is the making of goods for stock and through lack of proper controlling records entirely overlook the fact of their existence at the time when they are wanted. When material is closely accounted for under a plan in which the factory records are embraced in the general books, such finished or semi-finished goods cannot be overlooked, as a stock account of them will stand out as clearly as will a debit balance against a customer; the proof by balance plan will serve to keep the record on the surface—it will show that a certain amount of money is wrapped up in goods in process or in storesroom stocks, and the same "going over" process that is applied to accounts receivable can be applied to stores account and old material can be used to advantage, where without the knowledge presented by the records such old material would not be thought of; for as a matter of fact physically it might be covered up with other shapes or sizes of stock.

A dollar is a dollar to a solvent manufacturer, no matter what state it be in, whether in money, accounts receivable, or goods in process. The general run of workmen do not have the same wholesome respect for twenty-dollars' worth of castings that they have for a twenty-dollar gold piece, yet one such may have himself received in money the greater part of the value of such castings for his services thereon.

All business is a conversion of assets from one state to another. The prime pre-requisite for a substantial business is cash or its equivalent; given the tangible asset, cash, and the intangible but extremely valuable asset "know how," and a business is assured. The various evolutions and comminglings, through which these combined assets are put, finally produces more of the first class of assets than originally obtained; the increment to a large extent measures the value of the second class.

In the past, as a broad rule, a sharp controlling account has been kept of the first class of assets in its original state, cash; however it has seldom been a necessity to keep individual records of nickels, of dimes, and of each of the other denominations of fractional currency—that has not been necessary from the fact that money can be changed at the bank on short notice. This however is not so with that class of accounts which constitute the last stage of the evolution, finished product to sales. The manufacturer must know not alone what is the aggregate of his accounts receivable, but he must know the amount of each separate customer's indebtedness, so that he can keep after the customers through ordinary commercial channels, and finally complete the evolution by turning the accounts into the first stage of the succeeding evolution, cash.

The interim stages between the first stage, cash, and the last stage, accounts receivable, includes raw material, goods in process, and "know how"; a fitting system of records which shows the management any results worth while will include in the balance sheet synthetical accounts covering each stage of the evolution, to wit: Cash, Raw Material, Goods in Process, Finished Product, Accounts Receivable and Profits; the sum of the parts must equal the whole, and a cost system without proof of accuracy is naught but a series of memoranda.

Formerly the accounts of the great majority of manufacturing concerns consisted of merchandise account, manufacturing expense, and general expense; into the first account were dumped promiscuously the inventories, purchases of raw material, and pay rolls, and in such account sales of product were shown on the credit side, so that the net balance of the account showed nothing whatever of value to anybody. The concerns which used such a plan were not getting the full benefit of a system of good records. The conditions are no different today where the cost records are not a constituent part of the accounting plan; for broadly speaking, any records which will not disclose the condition of the business without stopping to take a

complete physical inventory are weak—very weak—and the management is not getting the benefits that would be derived from a system of good records. A going inventory is a prime prerequisite to such a system and is in itself a good asset in the way of a money-saving device; it saves money in so many ways that an article could be written on that one subject alone. That factory which can be run from the office is indeed well equipped—where foremen are not required to answer calls to the office, then return to their department to make certain investigations as to stock on hand, conditions of certain orders in process, etc., before an answer can be given to the office. That manager is indeed modern, and incidentally it is not to be spoken of as luck, because it is not; it is but the sure result of a determined and intelligent effort to have his records show him just what he wants to know—to have the data of his business presented therein both synthetically and analytically.

Along the line of running the business from the office the recollection comes to mind of a good illustration recently recited, wherein two very large corporations with a common line of product were concerned.

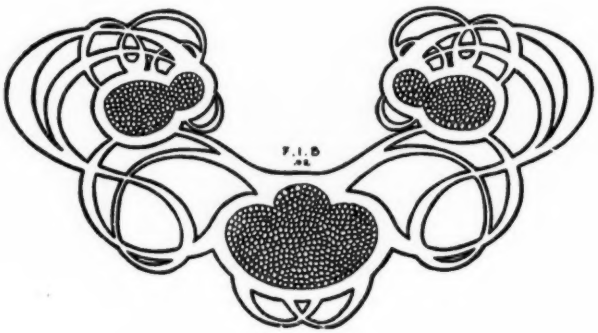
Each of these in turn was asked verbally by an executive officer of a concern which is a large user of the product, as to what delivery could be made on a stated quantity of goods; one concern used the long-distance telephone to a number of its plants, while the other concern consulted records within its office and was able to give a decisive reply within half an hour, and to know just what works was best able to turn out the goods, while the other concern had a number of superintendents on edge looking up data and could not give a positive reply short of two days.

Modern methods in producing goods and merchandising are essential, and modern methods in accounting must follow or the producer gradually falls behind in the race; records of facts must be substituted for the guesses of the past.

If the general records are divided into the following broad group of synthetical accounts, and the cost records are made to coincide or articulate therewith, then there will be presented data which will disclose what is the condition of the business any day, any week, or any month, as may be required, and the period of annual inventory can be done away with by verifying the accounts of goods of each class or kind, individually, while the stocks of such goods on hand are at their lowest ebb.

The controlling accounts should be:
Cash.
Bank.
Notes Receivable.
Accounts Receivable.
Accruing Manufacturing Expense.
Raw-Material Stores.
Goods in Process.
Finished Parts.
Finished Product.
Commercial Expense.
Real Estate and Buildings.
Investments.
Accounts Payable.
Sales of Product.
Capital Stock.
Surplus and Profits.

With an adequate system of time reporting, whereby time is charged against given order numbers, and with material issued only on authentic requisitions and charged to the order number upon which it is used, and (last but not least) a fair and just distribution or diffusion of manufacturing expense over goods in process, in such manner that all expense is absorbed, leaving nothing over or short—then will result facts concerning the exact condition of the business, each proving the other.



THE CONSERVATION AND USE OF WATER-POWER RESOURCES.

By H. von Schon.

II.—THE EFFECT OF WATER-POWER CONSERVATION UPON INDUSTRIAL DEVELOPMENT.

In a preceding article, Mr. von Schon proposed a definite plan for Federal, State, and corporate action in the conservation and development of water resources, and supplied some valuable data of explored water powers and their characteristics. In the present paper he examines the extent of the influence conservation might exercise on National economic conditions. A following instalment will conclude the study by presenting a typical, concrete case and furnishing a working solution for it.—THE EDITORS.

THAT industrial growth is clearly reflected by the amount of power utilized appears from the United States Census statistics of the comparative power consumption by some leading industries for 1900 and 1905:

	Horse Power Reported.		Increase.
	1900.	1905.	Per cent.
Iron and Steel Industries	1,670,000	2,720,000	63
Paper and Pulp "	765,000	1,122,000	47
Agricultural Implements	77,000	106,000	38
Worsted Goods	97,000	130,000	34
Cotton "	811,000	1,040,000	28
Silk "	61,000	78,000	28
All Industries	10,400,000	14,640,000	40

The use of electric power in the industries is stated by the same authority to have increased from 493,000 to 1,592,000 horse power, or 222 per cent. To what extent this increase is due to the growing utilization of water power for hydro-electric product is not clearly set forth, but its effect is evident from the fact that 800,000 horse power were added from the development of some thirty hydro-electric power plants transmitting the current to various distances with a maximum of two-hundred miles, while many smaller hydro-electric plants have come into existence during this period.

And this increased use of electric power in industries has developed under the most adverse conditions as regards the hydro-power sources—that is, the existing extreme flow fluctuations on almost every water course from which power is taken. I have designed power plants on some southern rivers, within recent years, where the

flood-flow volume is one hundred times the normal flow, the flood rise reaching fifty feet and more. The adaptation of hydro-electric installation to such conditions presents problems which can be met only by special and costly works and safeguards, and great loss of efficiencies of the generating equipment cannot be avoided during the periods of excessive fluctuations of flow while continuous output can be secured only by the aid of large auxiliary power installations. The waste flow over the many government dams on the Allegheny, Monongahela, Ohio, Muskingum, Kentucky, Green, Cumberland, and Tennessee rivers would develop many thousand horse power which could all be remuneratively marketed. Under the present conditions of uncontrolled flow such developments offer no attraction as a business enterprise, as they are prohibitive in cost; were it otherwise, the Government might secure a sufficient revenue from these to defray the cost of operating their navigation works, and near-by communities could enjoy the luxuries of economical electric-current service.

It needs no argument to convince that the hydro-power source is the most economical of all when the power element, water, is assured with reasonable constancy, nor can the economical character of the hydro-electric power plant and its equipment, as compared with any other type, be doubted, while economy of operation is of itself evident, as there is no fuel charge, and the costs, maintenance and depreciation are trivial when compared with these items in any other type of power plant. That the individual electric motor, as compared with the mechanical drive of shafts, pulleys and belts, is safe, clean, noiseless and economical, is also self-evident; in fact, considering that the steam-plant output must be constantly maintained at its maximum, whether the machines in the shop are operating or not, the economy of the electric power current, registering through a meter only so much energy as actually performs work, appears so great that even at high current rates it may not exceed 50 per cent of that of the most economical steam power service; in fact, the power consumer enjoys the privilege of paying for so much power only as he actually uses in the work.

The foregoing are some of the reasons why the use of electric power in the industries increases 222 per cent from 1900 to 1905, why the future increase will still be greater; hydro-electric current would soon displace steam-power current if its development were based on river-flow control.

All stream flow has its origin in so much of the precipitation as is not evaporated, this term embracing the quantity absorbed by vegetation and that which evaporates. The residue of precipitation runs

off the surface immediately, or sinks into the ground whence it feeds out gradually into the stream channels. The ratio of surface run-off to ground-storage supply depends entirely upon the surface and subsurface characteristics. A bared, hard-baked surface absorbs but little water; a forested area with its deep layer of leaves, brush, and humus is a sponge which becomes saturated with the water; it is a natural storage reservoir. The rapid storm surface run-off erodes the top soil and carries it in suspension, dropping it somewhere in the lower channels; timbered slopes obstruct this surface run-off; it gathers force but slowly; it finds no loose earth or gravel to carry along; the foliage canopy of the trees breaks the force of the downpouring rain, which reaches the ground gradually; finally, the snowfall on the open hillsides melts quickly under the influence of the wind and the sun, while that in the forest remains to melt gradually and then to sink into the ground.

The Chief of United States Engineers in his report for 1885, part 2, page 947 says this of the eroding effect of the flood on the James river:

"It has been estimated that at least 275,000 cubic yards of solid matter pass Rocketts Reef in twenty-four hours when there is a freshet not higher than ten feet. No account is taken in this estimate of the heavy material rolling along the bottom. It is probably far within limits to say that in such a freshet not less than 300,000 cubic yards pass in twenty-four hours. Large quantities of the lighter particles are carried down the river, but the heavier pieces that roll along the bottom move only by a rapid current and stop as soon as the freshet subsides."

That water waste with its collateral flood destructions of life and property, the constantly increasing erosions of the fruitful top soil and the consequent impoverishing of what remains, and the sedimentation of river channels, are primarily caused by the cutting away of the forests in the headwater regions of rivers, was recognized and acted upon by some of the European peoples hundreds of years ago; little Switzerland enacted a forest-conservation statute as early as 1680, which has been enforced in a most business-like manner since; 20 per cent of the mountain republic's area is in conserved forests, some 2,000,000 acres; the cost of maintenance and supervision is $1.32 and the net revenue, $2.25 per acre annually.

Germany's forest area is 35,000,000 acres; its system of forest preservation was inaugurated one hundred and fifty years ago. France has 23,000,000 acres of forests, all under admirable preserve laws. The combined population of these two countries exceeds that of the United States about 15,000,000. They now expend annually on forest preservation some $11,000,000 and enjoy a net revenue of about

$30,000,000, while the United States forestry expenditures last year aggregates $1,400,000 and the revenue $130,000. However, the American people are fully awakening to this forestry problem and energetic steps are being taken towards its economical solution. Several States have legislated for forest preservation by creating reserves and preventing destruction by fire. The total forest area of the country aggregates 600,000,000 acres, of which about 150,000,000 acres are now under Federal and State forest-reserve protection.

But while forest preservation is the prime and durable water conserver, the re-forestation of now wholly or partially denuded watersheds is the work of many years—yes, of generations, and even the present forest area can be maintained only by the promptest and most vigorous preservation policy. The annual growth of timber is not sufficient to replenish what is consumed; it does not exceed 60 board feet per acre or 36,000,000,000 feet from the entire area, while the lumber output alone exceeded this quantity in 1906; to this is to be added some 12,000,000,000 feet for shingles, cross-ties, pulpwood, cooperage stock, mine timber, lath, veneering, poles, and for distillation. And this is only the known consumption; there is yet to be reckoned that for firewood, some 100,000,000 cords or 50,000,000,000 feet, and last but not least what is destroyed by forest fires, which has been estimated as high as 12,000,000 acres in one year. The total timber consumption therefore is nearly three times the total annual new growth, and unless this is more nearly balanced very soon, water conservation by the aid of the forests does not look very promising for the near future, that is for fifty years or more to come. In the mean time the destruction and waste goes on unchecked; the floods will occur annually and will increase in violence rather than diminish; the sometimes navigable channels will be choked up quite as regularly by the detritus washed down from the bared hill sides, and the water powers of the stream, which alone might be of sufficient earning capacity to pay for all the reasonable and economically practicable flow-control works, are hardly of any utility because of the uncertainity of the available flow.

Prompt relief can be had only from one programme, such as was generally outlined in the article appearing in the September number of this Magazine. This comprises the storing of the largest practicable flood run-off per cent, and the distribution of this quantity during the dry season; in this manner only can flow control be had within a reasonable period of time, and some abatement of flood destruction and some betterment of power conditions will be realized from each effort.

Of the many influences which direct the industrial development of a country, none are of greater importance than those of transportation, and the watercourses are Nature's highways. Water transportation represents the earliest and, under proper conditions, the most economical means of conveyance; it was so when the towpath was as much in evidence as is now the steel track, and it will be so again. But in America's rapid industrial development of the recent past, water transportation appeared too slow, too inadequate to meet the great expansion, to keep up with the rapid advance of the pioneers; railroads were demanded; and because their success, it was thought, permitted of no water-transportation competition, railroads were built and canals abandoned. Now we are returning to first and sound principles. We are realizing the error and fully appreciate the mischief done. Railroads alone, after all, cannot keep up with the enormous rapidity of the pioneer's progress, cannot handle the grain he raises when the crop is good, and when times are a little off they cannot secure the funds to meet necessary betterments. Railroads put the canals out of business, but it will fall to inland water transportation on a proper scale, together and in co-operation with the best equipped railroad system which can be developed, to meet the greater transportation requirements of the future industrial expansion. On this topic the President of the United States, in his address to the Deep Waterway Convention at Memphis, Tenn., on October 4, 1907, said:

"Facility of cheap transportation is an essential in our modern civilization, and we cannot afford any longer to neglect the great highways which Nature has provided for us. The natural highways, the waterways, cannot be monopolized by any corporation. They belong to all the people and it is in the power of no one to take them away. . . .

"The industries developed under the stimulus of the railroads are for the most part permanent industries and therefore they form the basis for future development. But the railroads have shown that they alone can meet the demand of the country for transportation, and where this is true the rivers should begin to supplement the railroads, to the benefit of both, by relieving them of some of the less profitable freight."

Inland water transportation is the now popular demand, and it will be rehabilitated before long on a scale which is commensurate to our present-day requirements.

Of the economy of water as compared with rail transportation there is no doubt; the Interstate Commerce Commission reports that the average cost of moving freight by rail in 1906 was 7.48 mills per ton mile, while the statistical report of Lake commerce for the same year shows that 51,000,000 tons passed through the Sault locks, at the outlet of Lake Superior, in a season of seven months naviga-

tion, at an average cost of 0.84 of one mill per ton mile, and the cost of moving freight on the Ohio river in 1905, under anything but favorable water transportation conditions, was 0.76 of one mill per ton mile from Pittsburgh to Louisville, and from Louisville to New Orleans 0.67 of one mill per ton mile. This shows that water transportation was one tenth as costly than that by rail, and with continuous favorable conditions guaranteed by flow control of the rivers, and with low-cost electrical power, this low water-transportation rate may still be considerably reduced.

Transmitted electric energy comes to the fore also as an important transportation factor; up and down hill, almost regardless of grades, on economically constructed and maintained road beds, speeds the interurban electric through the country, bringing the town to the door-step of the farm, and the farmer, his family, and his products to the town, disposing of the factor time and of muddy roads at one swoop. Inland waterways and electric traction are destined to become the chief transportation methods of the future, and the development of both of these are collateral consequences of the conservation of water and of the water-power resources.

As was pointed out in the first article of this series, the complete development of the water power of a river, in the majority of cases, will also render it navigable, and this complete development is possible, and will prove profitable, if the flow of the river is under reasonable control. All the electric current which can be developed could find employment in transportation by the electrification of the present steam systems, for the electric interurban lines (which in not distant future, will parallel every important highway in the United States), and in electrically propelled craft on the inland waterways; every hydro-electric plant would be a supply depot of the electric energy for transmission lines or storage batteries. This problem of inland water transportation will not be solved by the continued dredging out of the detritus brought down by the flood waters, but by the diminution, if not the prevention, of the floods, by the storing of the flood waters and its distribution during the dry season, whereby the now three- and four-feet deep navigation channels may be increased to a constant depth of eight feet or more.

Past efforts to create slack-water navigation on the rivers flowing from the Southern Appalachian mountains have cost some $30,000,000 to date, and the results obtained are anything but continuous navigation; there is either a feast or a famine of water, and then the loss of much of the work done and renewed dredging. From a late report of the United States Geological Survey on the relation of the

Southern Appalachian mountains to inland navigation, it appears that all-year navigation may be secured on the Potomac, James, Roanoke, Great Pedee, Yadkin, Santee, Wateree, Savannah, Altamaha, Oconee, Chattahoochee, Monongahela, Youghiogheney, Kanawha, Tennessee and Ohio, by storing approximately 30 per cent of the flood flow of these rivers in reservoirs which have been sufficiently examined to determine their storage capacity, flowage area, and cost of required storage works; and that the proper distribution of this per cent of the flood waters during six low-flow months annually will, in normal channel sections, maintain a navigable depth of about eight feet, while the present system of channel improvements does not claim to secure better than four feet. As of the relative cost of the two methods there can be no doubt. Channel conditions secured by aid of flow control have some permanency; those without it are changed by every flood. It has been urged against such a programme of flood storage that the initial cost would be so enormous that the country would not stand for it. I claim that the enhanced water-power capacities alone will carry such an investment—yes, that the prevention of flood destruction, or its considerable diminution, would do so likewise—and, thirdly, that the waterways thus created and their maintenance as such would equally well meet this cost by the consequential savings of the cost of the present improvement methods. Again, it has been said that the elements of danger from the possible failure of any of these storage works are so awe-inspiring that they will never be authorized. To this it might be replied that we are living in an age when great things are done, and that storage dams, in suitable locations, can be made as safe as any works created by men; that they can be made a part of the everlasting rocks and be as secure as these. It is hardly believable that American enterprise and genius will be found inadequate to create safe storage works for any purpose.

But not only may water *transportation* be thus rehabilitated, but water *powers* as well, and enormously enhanced in value. A similar recent report from the United States Geological Survey on the relation of the Southern Appalachian mountains to the water powers quotes the present power capacities of the rivers before enumerated at 2,800,000 horse power, while the storage programme as outlined would increase them to about 7,000,000 horse power. Late Census statistics quote the water power used in the southern States at 150,000 horse power—about 5 per cent of that now available and 2 per cent of what can be created by flow control. If the available water powers of the southern States could now be economically developed,

the cotton-goods industries, which now utilize over 1,000,000 horse power, would soon be located in the land where the cotton grows, and the wood pulp and paper industry of New England would have to meet a formidable rival in paper manufactured in the South from rice straw and other there plentiful fibrous materials, such as are now being made into paper in Europe. With such an asset of electric energy, and the consequent low cost of it, electric heat would become available for the reduction of ores, and Pennsylvania would not long continue to hold the supremacy in the iron and steel industries. Water conservation and the complete development of the available water powers would indeed give to the industrial development a new phase, as power is a factor of great import.

And this holds good not only of the South, but of the North and the East and the West. The rivers flowing from the White mountains, the Alleghenies, and the Rockies, all are proper subjects of this conservation programme and the benefits to be realized therefrom. Whether this is to be initiated and carried out by the States or the United States is a question of powers and policies as determined wisest by the people; at any rate it is a public and in the majority of cases, a national subject. The great, the broad, the all-overlying need is to stop the waste, to do things for the conservation of this, the greatest of all natural resources, water; to sober up from our orgies of indulgence so that the generations to come may be saved from the pangs of want; to act as reasonably and wisely in regard to our natural resources, as a people, as the normally constituted American business man would act with his own.

I would suggest that this is a proper time for the serious consideration on the part of all commercial, industrial and professional bodies, of the engineering societies especially, of this question of conservation of water. This seems to be the time for the initiation of an energetic campaign, now that the general subject of conservation of our natural resources has received such important impetus on the part of the National and of several State administrations, and has been given commensurate importance among the weighty questions of the day in the plaforms of the political parties, for all proper influences to be exerted to preach and spread the gospel of conservation in every community and State, so that a united interest may become enlisted and the desired results be obtained as speedily as practicable.

This article is to be followed by a typical case of water conservation, and of its effects and results as compared with the methods and policies followed in the past.

SYSTEMATIC FOUNDRY OPERATION AND FOUNDRY COSTING.

By C. E. Knoeppel.

The thought underlying Mr. Knoeppel's work is that "action is the result of conclusions based on reasoning applied to comparisons." His purpose is to lay down practical, sensible methods by which the data essential to comparisons may be obtained. His series beginning in this issue will cover all elements entering into the problem of systematic, profitable conduct of the foundry. A brief topical outline of the discussion is given on pages 96 and 97.—THE EDITORS.

IT is doubtful if, in the whole realm of business endeavor, any industry has received less intelligent consideration from those most interested than the foundry industry, with its millions of tons of yearly product, finding its way through our twentieth-century commercialism to all parts of the world. That this vastly important industry, as a whole, is far from measuring up to the limit of its possibilities, is a fact that will admit of little if any argument. It is about time that its old methods were done away with and new ones substituted—about time that its position should be on a plane equal to that now occupied by the machine shop—about time for it to be looked upon as something infinitely more than a "necessary evil," a "dirty hole" where almost any kind of rigging, any method was good enough—about time for it to be given as important a place in the organization of a business as any other department; and fortunately, the indications are that the foundry is coming into its own as is evidenced by the attention given to such subjects as organization, mechanical arrangement, rigging, tools, chemistry, accounting, etc., by the many associations devoted to the interests of this industry. Nor is the move for greater efficiency confined altogether to the United States, as appears in an extract from the address of President Pilkington, of the British Foundrymen's Association, at their meetings, August 6, 7 and 8, 1907:

"It appears to me, however, that although there are many excellent exceptions, there is no department in our great iron and steel trades which is so antiquated, not only in commercial methods, mechanical arrangement, in systematic organization and scientific methods as that of the ordinary foundry industry. What we want to do in this country is to 'wake up,' and it is the duty of associations such as ours to awaken our foundries by such criticism and teaching as we are capable of.

"If it requires a careful organization in foundries on special lines of work, it is therefore clear how much more so it is requisite, if the ordinary jobbing or general foundry be taken, which is on varying work of a very different character. The system has to be an extremely elaborate one, carefully thought out, to get the exact cost of each of the different jobs at different classes of castings produced, which can be the only correct system to use to form an accurate basis for sending in proper tenders for work."

It would be almost impossible to attempt to determine by what process of reasoning foundry managers have allowed their shops to stay for so long behind the machine shop, in the way of mechanical arrangement and systematic methods. We go into a machine shop; we see an excellent equipment; perhaps the machines are electrically driven; we see electric cranes, air hoists, etc.; we find the building well lighted, heated, and ventilated; we note the excellent equipment of small tools, jigs, gauges, etc; we are surprised at the systematic handling of raw and finished materials from and to the machines, as well as at the way the order, time, and cost details are handled, and we marvel at the wonderful progress made by the machine shop. Now for the other side of the picture. We enter the foundry and the first thing that is liable to greet us, if it be winter, is gas fumes from a number of coke fires; we find the ventilation to be far from what it should be, and if we are in the foundry when a heat is being taken off, it is a hard matter to see from one end of the shop to the other on account of the smoke and gas; we find a flask equipment that saw its best days quite a little time ago, some being so bad that a really good moulder would dislike to use them for making even the commonest kind of work; we see flasks piled in every conceivable place in any old order; we see a poor lighting system; pig and scrap arranged in all kinds of ways; in fact, everything seems to be disorder and confusion. We find that the melting—a matter of the utmost importance—is left to ignorant men; that little care is exercised in weighing the metals, that in throwing into the cupola, it sometimes makes little difference how or where the metals are thrown as long as they get into the cupola and out again as iron, be it good or poor. As to a systematic method of gathering pertinent data, we are likely to find this work in a very crude state; but the surprising feature is that the foundry manager wants good castings in maximum quantities and he does not want them to cost more than they should, either.

It is strange sometimes to come in contact with these men, who, considered shrewd, display such a small amount of business acumen in expecting maximum results from equipment and methods that are far from being up-to-date and efficient. A workman, whether he be a

machinist or moulder, is about what his environment makes him, and the efficiency of a workman is generally limited by what he is given to work with. It is therefore safe to conclude that maximum efficiency, in the foundry, in the way of increased production and reduced costs, is in proportion to the attention paid to such matters as equipment, proper working conditions, accurate methods, etc., and it will be found that results are better as the foundry, as a plant, approaches the plane occupied by the machine shop.

If we assume that it is right and proper to give the machine shop the careful attention that it has received—and results are bearing out this assumption—then why is it not right and proper to give the foundry like attention? Is not this our starting point? Most of the raw material used by the machine shop is the finished product of the foundry, whether it be iron, brass, or steel castings—the product of a jobbing foundry or a foundry in conjunction with a machine shop. Why start half-way? If an architect designs a building, he pays particular attention to the matter of foundation; is not the foundry our foundation in so far as the machine shop and those who use its product are concerned? Should not one rule apply to all branches, instead of conducting the business in a lax and careless manner "to the machine-shop door" and then exercising extreme care "from the machine-shop door"? The work in the machine shop is, to a large degree, mechanical, while in the foundry we find brain and muscle the principal factors. This naturally increases risk, for in the machine shop a drawing is furnished, the piece to be processed is placed in the machine, and this simply requires the attention of an operator who has little to do other than to watch his work, using the necessary tools for this purpose and seeing to it that the piece or operation is completed in accordance with the drawing or sketch. Nothing but the carelessness of the machinist himself can result in the loss of the piece, unless it be inaccurate tool equipment, which as a rule is carefully guarded against. In the foundry the moulder has sand, a pattern, and a flask with which to work. His pattern may or may not be what it should be, while it is safe to assume that his flask has been used and kicked around for so long a time as to make it unfit for anything else but firewood, while his sand is likely to have the consistency of grit. Out of all this, he is expected to furnish a good casting, but he does not always do so. Comparing machine shop with foundry, the element of loss must be greater in the latter; for even though a moulder might perform his work well, in spite of what he has to work with, any one of a number of things might happen which would result in a bad

casting. Carelessness is often responsible for loss, but there is no getting away from the fact that "contributory negligence" on the part of the management is much in evidence.

Again comparing machine shop with foundry, we find daily wage per man averaging more in the foundry than in the machine shop, in the majority of cases. It should be evident that the greater the risk, loss, and wages paid in any one department, the greater should be the attention given to it; if this is the case in the foundry, no logical argument can be advanced against the conclusion that the foundry is justly entitled to a *greater* degree or attention than is given to the machine shop, in equipment, mechanical arrangement, and methods.

Foundries can be divided into two classes—jobbing and specialty (in conjunction with a machine shop)—but in either case the desire is a maximum production at a minimum cost. The jobbing foundry depends upon a reasonable cost to be able to make prices which will result in orders, while the castings from the specialty foundry go to make up a machine, the cost of which must be kept within certain bounds in order to sell them at a profit.

The various items of expense make up total cost, which added to a reasonable profit gives the selling price. If this price is too high, the order is lost. It will not do to sell below cost very often, although it is sometimes necessary to take work at cost in order to keep the output up to a required amount. Of the three items just referred to, we find selling price dependent upon cost and added profit, while the percentage of profit depends to a large degree, if not entirely, on cost; so that the logical inference is that cost constitutes the basis of a sale, regardless of whether the sale involves a machine or simply castings. Now then, if we can arrange through some method or other to watch this item of cost carefully, a means is provided for enabling us to get it down to a consistent figure and keep it there.

A manufacturer with no system at all will keep some sort of a record showing him, at the end of the year, what his sales have been. He finishes a business year, we will say, with sales amounting to $100,000, but in comparing the year with the preceding one, he is surprised to find that the sales were $125,000, a decrease of $25,000. As every effect has its cause, he concludes at once that something was wrong. Upon what does the finding of this something depend? First upon a *comparison* to find the *effect*, which in this case is a reduction of $25,000 in the sales, and then upon an *analysis* to find the *cause*. It is evident that the time necessary to make this analysis depends altogether upon the facilities for the comparison of items of like nature.

His comparison showed him that something was wrong, and his conclusion may be that he was forced to make his prices higher in order to offset higher wages paid and greater material costs; which might have been responsible for the falling off in the sales—although this might not have been the reason, which remains to be found. A flood of questions come to him regarding production, costs, percentages, etc., but it is next to an impossibility for him to answer them owing to his inability to pick past performances to pieces.

Does it not stand to reason that he should have had compilations of data and information on hand, which would have enabled him to compare and then analyze? Most assuredly it does, but to *compile* he must *secure*—my reason why a system of costing is an absolute necessity in any manufacturing establishment. To sum up briefly, we first of all have effects or results of every kind and description; if these are gathered or secured in a systematic manner, compilations can be made, and by comparison for different periods, analysis will point out the way for ascertaining causes. Once a manufacturer knows the *why*, he is in a position to plan for maximum efficiency.

In the foundry business competition is not getting any easier, although it might seem that it was from the way many foundries are managed. There are many cases where one foundry will make a price of $2.50 per 100 pounds on certain work, and another will ask $2.35 for the same work, regardless of whether they can make the work for this figure or not. It seems that many either go on the assumption that "ignorance is bliss," substituting "I think" for "I know," or they look upon the matter of basing a price as so simple as to render unnecesssary any method for accurately determining what should be charged. The competition of the successful foundry is not the hardest to meet, but rather the ignorant and unintelligent competition of the concerns who know as much regarding where they stand as a child does about the Greek tongue, such concerns making a gambling proposition out of what should be up-to-date business in every acceptance of the term. Even if price is not the important consideration, the need for a proper system of costing is none the less, for the ultimate purpose of any system of accounting is a reduction in the expenses and an increase in the production, brought about, as before stated, by a careful analysis of all pertinent information. This applies to the specialty foundry as well as to the jobbing foundry, for the desire of manufacturing concerns operating their own foundry is (or should be) a foundry production costing no more than the castings can be purchased for outside.

In the specialty foundry, the discoveries of actual conditions are not made as quickly as in the jobbing foundry, because the output of the specialty foundry is usually governed by the orders received by the machine shop, while the jobbing foundry must keep constantly on the jump, to get enough business to keep the plant running full time, the result being that the specialty foundry is looked upon as a sort of "necessary evil" to facilitate the work in the machine shop, and consequently receives less intelligent consideration than it otherwise would. The result, if the truth were known, is a high cost of production; for not knowing where the leaks are, the management is in no position to stop them or cause them to be stopped, whereas if they would once put their foundry on the same basis as the machine shop, the results would be such as to cause the saving of considerable money, or the foundry would be closed down and the work sent outside when only good castings would be paid for at the market price.

How can a foundryman find out where and how he stands? From his cost system, which if properly devised and introduced will inform him regarding the cost to produce his output; what he is making; the productiveness of his men and the plant, etc., and by a segregation of all the details, then a classification and an analysis, he is in a position to pick the bad threads from the good, and instead of saying "there is something wrong *somewhere*" (anyone can say this) he is able to say *"here is the fault."*

Is foundry accounting simple. Ask some foundrymen this and they will reply that it is, and confidentially tell you that the total wages paid, added to the materials consumed, plus the expenses, will give the total cost of producing castings; dividing by the weight of castings produced will give the cost per ton of good castings; deducting this from the selling price shows the profit—if the cost is not larger than the amount received. Or they may tell you to classify product under headings of bench, loam, green-sand and dry-sand work, and divide the total cost of each group by its castings produced. The argument that might be advanced in favor of these two methods is the ease with which costs can be figured; but unless the determination is an accurate one the methods are worse than none at all, inasmuch as the results would be misleading, and no foundryman can afford to work in the dark, especially in these times. The methods outlined would be accurate in shops having a uniform class of product, where the increases or decreases in the material, wage, and expense costs are proportionate to the increase or decrease in the

weight of the castings produced. Such a condition exists in but few shops, as will be evident when one considers that in the majority of foundries, a piece taking 10 hours to make might weigh 500 pounds, while another piece made in the same time might weigh 2,000 pounds, or two pieces weighing 1,000 pounds each might be made in 3 hours and 7 hours respectively; this shows that we can have the same weights and different labor, and same labor and different weights, as two extremes with numberless fluctuations between; it shows also that the relation between weights and labor are far from being proportionate; this being the case, the methods above mentioned must be discarded on account of their inaccuracy, as this will show:—

We will say that the cost determination on the entire month's output or a group output, shows it to be $2.50 per 100 pounds, made up of the following elements:—

Material	$1.00
Labor	.75
Expenses	.75 (100%)
Total	$2.50

Take for instance two castings, alike in every particular, but made from different patterns, one being so constructed that when finished it weighs 2,000 pounds while the other weighs 3,000 pounds. It stands to reason that the difference in the making time will not differ materially, if at all, but in costing at our rate of $2.50, we get a cost on the 2,000-pound or "A" castings of $50, while on the 3,000-pound or "B" pieces, the cost is $75, the details being—

"A" 2000 lb.		"B" 3000 lb.
$20.00	Material	$30.00
15.00*	Labor	22.50*
15.00	Expenses	22.50
$50.00 (C)	Total	$75.00 (D)

Instead of two different items of labor as shown at (*), the labor on both pieces was either $15 each, $22.50 each, or *neither;* in fact, the labor might have been $10, $8, or $12; but on the assumption that it is $15, our table should read:—

Case No. 1

"A" 2000 lb.		"B" 3000 lb.
$20.00	Material	$30.00
15.00	Labor	15.00
15.00	Expenses	15.00
$50.00	Total	$60.00
.....	Cost "D"	75.00
.....	Difference	$15.00

Assuming that the cost is $22.50 each for both and we have:—

Case No. 2.

"A" 2000 lb.		"B" 3000 lb.
$20.00	Material	$30.00
22.50	Labor	22.50
22.50	Expenses	22.50
$65.00	Total	$75.00
50.00	Cost "C"	.....
$15.00	Difference	.....

It is therefore evident from case 1 that cost "D" was overestimated by $15, while case 2 shows us that cost "C" was underestimated by the same amount.

Getting down to a strict commercial basis, by which any method should be measured, we find as far as concerns this particular transaction (which is far from being an isolated case) that overestimation and underestimation are the result, the significance of which is no doubt apparent to every foundryman whether he is running a jobbing or specialty foundry. As far as the jobbing foundry is concerned, overestimation means that competitors are very likely to get the orders of which the costs have been overestimated, while underestimating carries with it the orders, at a loss in producing; neither of these results is at all desirable. The machine shop using the castings from its own foundry, will have its output when overestimation occurs costing more than it should, and less than it should when costs are underestimated. This is liable to result either in loss of orders or loss in money and the possibility of *loss both ways* is something to avoid. At any rate, it should be seen that as far as shops having a varied product are concerned, the determination of costs on a tonnage basis is most inaccurate as well as misleading and consequently of no value whatever.

What method should be used, and how may costs of production be ascertained, so as to insure not only results in the way of greater efficiency, but accuracy, comprehensiveness, and simplicity? To answer this question will be the purpose of a series of papers of which this is the first or introductory. The aim will be to show, step by step and in detail as far as possible, the work of costing, from the proper securing of the numberless details to *recording* of final analysis for reference purposes. In scope the series will consider and discuss the proper apportionment of burden; the elements entering into the burden; how they are absorbed by production; purchases, and the proper handling

of materials received; charging and billing; inventories; returns and their analysis; cupola data; material adjustments; labor—direct and indirect; expenses; the accounting and compilation of cost information; focusing of pertinent details at one point; facilitating and recording analysis; standardization of costs, work, duties, and other points which affect the success or failure of the foundry enterprise. The *how* and *why* of things, with illustrations and definitions where possible, will receive special attention, so as to make the series clear to the readers. It is reliable and accurate information, carefully secured, compiled, segregated and then analyzed, which enables a manufacturer to plan for maximum efficiency in such a way as to lead him to feel that his efforts will count for something.

NOTE.—To insure against "it all looks good on paper," the author decided to use, as a basis, a system actually in operation and giving results, instead of building methods around a hypothetical case. To do this, it was necessary to find a foundry having, as a product, a varied line of light and heavy work as well as a foundry with a reasonable sized output of recognized quality. It was also necessary to find a foundry successful in a commercial sense, and in a locality where competition is keen and where there would be no question but that the methods and systems were playing a large part in the success of the enterprise.

Such a foundry was found in Erie, Pennsylvania, under the name of the Walker Foundry Company, its president and general manager, Mr. G. I. Black, kindly consenting to give the author all the information necessary regarding the details of the business, in order to make the series as strong and complete as possible. The business in question, which was started in 1893 with about 15 employees, is now operating with a capacity of 250 employees at an average daily tonnage of 30 tons; the shop is a large one, having three floors—main, side and bench—with two cupolas, one taking care of the light work, the other the heavy work, so that the methods which have assisted in making this enterprise successful, should prove of value to those interested in the foundry industry.

The systems in use today—which have been revised only when it was necessary to meet changed conditions—are the result of the combined efforts of Baker-Vawter Company, Chicago; J. C. Loughry, Elyria, Ohio, and Mr. Black, who has made a careful and consistent study of costing methods—quick to introduce any method which would tend to make his business more successful—and with the author is now at work on a campaign of standardization and betterment, the result of which will be given to the readers of this magazine, in the papers which are to follow.

THE AUTHOR.

EDITORIAL COMMENT

Mastery of the Air.

AERIAL navigation so inspires the imagination that it is easy to overestimate the successes obtained and to overstep probabilities in forecasting the future. It has been demonstrated that under given conditions a dirigible balloon carrying many passengers may be manœuvred safely for several hours, and an aeroplane carrying one or two may fly swiftly for one or several hundred miles; but the "conditions" are so rarely "given" that these solutions seem after all to apply but to single and exceptional cases and not to the general problem.

The Zeppelin and Parseval airships —just as the multitude was ready to acclaim them conquerors of the air— were destroyed by a mere fillip of the wind's finger tip. The scope of Wright's wonderful machine and the extent of the inventor's success are marred by the distressing fatal accident of September 17th; but the limit does not lie here, but in the fact that he had to wait hours, days, almost weeks, for atmospheric conditions good enough to permit him to fly at all, and could launch or land only by the aid of equipment or environment which left the feat still immeasurably far from free-ranging locomotion of the air.

For certain purposes where risk and cost of performance are wholly negligible (as in war, sport, and improbably some emergencies) the problem is solved or is very near solution. For broader employment this problem of navigating a medium subject to furious and not always foretellable disturbance, by a vessel immersed in that medium, is as far as ever from solution—is probably insoluble. It is much like attempting to build a submarine that can travel safely in the rapids of Niagara.

Resumption Enforced.

THE season approaching a presidential election is notoriously a time of partial suspense in business, and this year — with its atmosphere of uncertainty trailing after it from a preceding depression—could hardly be expected to prove an exception. The hesitation, however, seems to be in fixing the rate at which the future shall be discounted, rather than in deciding what that future is to hold for our industries.

Meantime physical conditions are rapidly reaching the point where a large increase of activity will be forced upon manufacturers in spite of all hesitation and of the acquired inertia of the past depression. Retrenchment in maintenance of equipment, makeshift and expedient in the repair and upkeep of still active machinery, inattention to the condition of machinery which must soon be started, have gone as far as they can go. Reserve and surplus stores have been drawn down to nothing; idle equipment has been "robbed" to maintain live equipment until Peter can no longer pay anything more to Paul; new purchases must be made. The slightest increase in the amount of moving machinery means now considerable increase in the purchase of fittings, auxiliaries, supplies—means considerable expenditure to bring the dismantled outfit up to condition. And just as contraction circled rapidly back upon the heads of those who began the retrenchment, so renewal and resumption will spread in circles, ever enlarging, no longer "vicious," but now beneficent.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

STEAM-ELECTRIC MARINE PROPULSION.

THE ADVANTAGES OF ELECTRIC TRANSMISSION IN SECURING HIGH EFFICIENCY OF BOTH TURBINE AND PROPELLER.

William P. Durtnall—Institute of Marine Engineers.

A PAPER read recently before the Institute of Marine Engineers by Mr. William P. Durtnall, abstracted in *The Electrical Engineer* for July 24, gives one of the most interesting discussions of the question of electrical transmission for marine propulsion that has come to our notice. The low efficiency of the direct-connected turbine system is due to the fact that the steam turbine works most efficiently at high speeds, while the propeller efficiency is higher at low speeds. Mechanical gear and compressed air have been tried as means of transmitting the power of high-speed turbines to low-speed propellers but with unsatisfactory results. As Mr. Durtnall points out, the electrical system seems to be the one in which the greatest possibilities lie, and the system he proposes, an outline of which is given below, would seem to solve the problem in a practical and efficient manner.

The turbine is in several ways an almost ideal motor. It is easy to open up and repair, and the simplicity of its working parts and ease of lubrication make it especially suitable for use with highly superheated steam; it gives a uniform torque and is, at least in some cases, highly efficient under great variations of load. Its direct application for marine propulsion has secured a very strong hold, but for this purpose it has a few but important disadvantages. It must be designed to run at low speed to permit the use of a propeller of high propulsive efficiency, and consequently its weight and diameter are increased to a very large extent. The blade clearance is also greater, involving higher consumption and leakage of steam. Added to these disadvantages are the difficulty of reversing and the increased steam consumption per horse power when working below full load and speed. Tests on the "Lusitania" have shown the steam consumption per shaft horse power per hour to increase from 14.46 to 26.53 pounds when speed was reduced from 25.4 to 15.77 knots. The ability to manœuvre is perhaps of small importance with ships making long runs, but it is very important for those making short voyages and for ships of war; it is usually secured by the installation of astern turbines of about one-third the total ahead power. This arrangement is not satisfactory, as the dead weight is considerably increased, and full power astern is not secured. The latter would be possible only with a full duplicate set of turbines, and for many vessels considerations of safety might justify such an increase in dead weight. In order, therefore, to secure the complete success of the steam turbine as used for ship propulsion, some means must be provided to allow the turbine to run at high speed and the propellers at comparatively low speed, and so secure economy in both

cases, and also to provide reverse motion for all shafts.

The greatest possibilities lie in the method of electrical power transmission. This system supplies the very elements required to take advantage of high-speed turbines by utilizing them to drive electric generators, thus securing a reduction of turbine weight and high economy in steam. The current generated would be used to supply low-speed electric motors coupled to moderate-speed, large-bladed propellers of high efficiency. This method of power transmission would do away with the necessity for extra turbines, shafts and propellers for reversing. The turbo-generators would always run in the same direction as regards speed rotation while the motor could be run efficiently in either direction and at any speed, with the additional advantage that changes of direction and speed to meet the conditions of practice could be made instantaneously. Both motor and generator could also stand very severe overloads for short periods without damage.

For marine propulsion electrical power transmission can be successfully effected only by the use of polyphase alternating currents, with synchronous generators and squirrel-cage induction motors, on account of the low cost and weight per horse power, absence of commutators, and high efficiency of these machines. In generators of this type the armature is a stationary closed ring, inside which the field magnet revolves. The main current is generated in the stationary ring and taken off direct, without any of the intermediary devices necessary when collecting current from a rotating source. The field magnet receives its exciting current from a small direct-current machine mounted on the generator shaft. This current, which only amounts to about 2 per cent. of the generator output, is delivered to the revolving field through simple collecting rings. Such combinations, as converters of mechanical into electrical energy are characterized by exceptionally high efficiency, light weight, and low steam consumption. The efficiency varies from 85 per cent. in small sets, to 98 per cent. in large installations; the weight is between 35 and 22 pounds per kilowatt output continuous rating, according to speed and other circumstances; while the steam consumption in 7,500 kilowatt sizes, running at 750 revolutions per minute, with 160 pounds steam pressure at the stop valve, 150 degrees superheat, and exhausting into 27½ inches vacuum, is only 13.5 to 14 pounds per kilowatt-hour, including steam used for auxiliaries.

The powerful starting torque, light weight, simplicity, low cost of construction, mechanical strength, durability, and running characteristics of the induction motor make it especially suitable for marine work. As there is no commutator and no sparking limit the output can be carried much higher per unit weight than in other machines. These motors can be built for marine work of from 1,000 to 10,000 horse power continuous rating, weighing 35 to 20 pounds per brake horse power, with an efficiency of 93 to 97 per cent. Although polyphase motors are termed non-synchronous, they always tend towards synchronism, and with squirrel-cage rotors the variation in speed from light to full load seldom exceeds 5 per cent., even in small sizes, and would probably not exceed 1 per cent. in large sizes. The main working current passes through the stationary part of the motor only, facilitating strong and reliable construction for the conductors and rendering the machine so simple as to require no skilled and very little unskilled attention, with very low maintenance cost.

"Let us assume that we wish to know what will be the steam capacity of the boilers for a vessel fitted for electrical transmission. For four propellers, each requiring to rotate it 1,000 brake horse power at 250 revolutions per minute, the motor would be of the polyphase induction type, with squirrel-cage rotors, and with stators wound for full, half, and quarter speeds. The generators would in this case consist of two turbo-alternators and exciters capable between them of generating and supplying 3,250 kilowatts, and running at a speed of 1,500 revolutions per minute with steam

at, say, 150 pounds pressure and 150 degrees F. superheat. These alternators would be, say, two-pole machines, therefore, if the motors are wound for 12 poles (for top speed), it will be equal to 6 to 1 reduction in turbine for propeller speed. For half speed the second winding would be arranged for 24 poles, 12 to 1 reduction with two sets of windings in parallel; and for quarter speed this winding would be arranged for 48 poles, 24 to 1 reduction. With these windings in series the synchronous speeds would thus be full speed 250, half speed 125, and quarter speed 62½ revolutions per minute. For the top speed the above turbo-alternators would be coupled up in parallel, and when supplying the motors with current would generate 3,250 kilowatts, and the consumption would be, say, 16 pounds per kilowatt, or 52,400 pounds of steam per hour, or 13 pounds per shaft horse-power, which compares, in my opinion, very favourably with what would be required with direct-coupled turbines working under similar speed and circumstances, and would be more in the order of 22 pounds per shaft horse-power, 88,000 pounds; therefore, difference in steam consumption 36,000 pounds per hour, representing a saving of no less than 41 per cent. in boiler capacity comparatively. Now, at half speed we will close down one of the turbo-alternators altogether, and we shall probably only require, say, 600 shaft horse power at this speed; therefore, I will estimate the efficiency of the motors at this half speed and load 60 per cent.—740 kilowatts. The turbo-generator would use, say, 24 pounds of steam per kilowatt-hour with this load, but would run at top speed, although at half vessel speed, and this is equal to 17,760 pounds, while the direct-coupled turbines would each run at half speed, and the consequent steam consumption would be not less than 47 pounds per shaft horse-power to 28,200 pounds of steam, or under these circumstances there would be a saving of no less than 11,800 pounds per hour, or equal to 37 per cent. saving in steam at half vessel speed (and I have estimated on the easy side for the direct-coupled turbine). Assuming these estimates to be approximately correct, it may be asked, what will be the relative weights between the two systems? So we will take first the four motors:

4,000 brake horse-power at 35 pounds per horse-power developed	say	62½	tons
Conductors, switchgear, etc.	"	6	"
Two turbo-generators as above	"	70	"
Condenser for above	"	19	"
Steam-piping, etc.	"	13	"
Air-pump and motor	"	6	"
Circulating pump and motor	"	7½	"
		184	tons

While the weight of the direct-coupled turbines and part of the propeller shafts, shaft tunnels, etc., including condenser, steam-pipes, etc., air and circulating pumps—which would have to be arranged to deal efficiently with the 88,000 pounds of steam—would be at least (taking the speed of the turbines at 250 revolutions per minute) 148 tons, showing that the electrical machinery would be about 25 per cent. heavier, but it is here necessary to point out that that only applies to the plant from stop valve to propeller shaft connections. We will now look into the possible saving in operating costs and weight at the other side of the stop valve, and taking the data that have been published as regards the weights of cylindrical boiler, stoke-hold equipments, etc., which are as follows, when taking reciprocating engined vessels into account. It has been stated that with good cylindrical boilers, including small and large mountings, fire-box and funnel (boiler empty) with forced draught, pipework, including all pumps, water, steam, and exhaust pipes, gratings, platforms, etc., weight per indicated horse-power in boiler-room reaches 180 pounds. Therefore, the weight of the boiler-room equipment of a vessel in which would be installed, say, two reciprocating engines running condensing would approximately be as follows: Taking 180 pounds boiler equipment weight per indicated horse-power, then 4,700 indicated horse power, with a mechanical efficiency of 85 per cent., would equal 4,000 brake horse power = 377 tons, and in order to get at the steam consumption per ton of boiler weight we will allow, say, 16 pounds of steam used per indicated horse power, including steam

required for auxiliaries and losses due to radiation, etc., therefore = 75,200 pounds of steam per hour per ton of boiler-room equipment. Under these circumstances the boiler-room equipment would weigh, for the 52,000 pounds of steam that will be required for the electrically-driven vessel, 260 tons, while for the direct-coupled turbine-driven vessel the boiler equipment would weigh not less than 440 tons. Hence, with electrical transmission there will be a saving in weight in boiler-room equipment for the same propeller horse-power of not less than 40 per cent., or 180 tons.

"Now, as regards coal consumption and comparative saving in this direction, we will take it that with hot feed, clean flues, and with good Welsh coal, it is possible to evaporate, say, 10 pounds of water per pound of coal burnt, so that we have in the direct-coupled turbine vessel a coal consumption of 8,800 pounds and in the case of the electrical vessel 5,200 pounds, or a saving of 1.6 tons per hour, which equals in a ship running for six days a net saving in favour of the electrical scheme of no less than 230 tons less dead weight, and, what is very important, running cost; and this important matter will be surveyed with somewhat close interest by cargo vessel owners, as it may be at the same time observed that the propellers are run at about the same low speed as is necessary and usual in these slow vessels. In order to secure economy at the propeller, and for the usual speed of such cargo vessels, it is possible to further reduce the speed of the propellers should it be considered necessary to suit the ever-varying conditions that will possibly be met with in practice, and this could be secured by slight increase in the weight of the motors only, the generating plant weight remaining the same. The system is very suitable for conversion of existing single-propeller vessels, while in twin-propeller ships a certain advantage is secured in economical operation by the use of one power generating plant working twin screws, with their various advantages, certain security, and ease of control."

THE CARE AND MAINTENANCE OF STORAGE BATTERIES.

A REVIEW OF OPERATING METHODS AND OF THE CAUSES AND REMEDIES OF BATTERY TROUBLES.

F. A. Warfield—The Electric Journal.

IN the following abstract of a paper by Mr. F. A. Warfield on the care and maintenance of storage batteries, published in *The Electric Journal* for August, will be found an interesting and valuable supplement to Mr. Percival Robert Moses' articles in THE ENGINEERING MAGAZINE for September and in the present number. Mr. Moses deals with the construction and application of storage batteries and their auxiliaries; Mr. Warfield with the proper methods of charging and discharging, the conditions necessary for most efficient operation, and the causes of, and remedies for, the more important and common battery troubles.

"Batteries should ordinarily be charged at the normal, or eight-hour rate, which in all cases is specified in the contract under which the batteries are sold. The voltage required to start the charge is about 2.15 volts per cell. If this voltage does not give the required ammeter reading, adjustments should be made by means of rheostats installed for the purpose. When charging a fully discharged battery, the writer has usually obtained best results by using a variable rate of charge, and the following method is suggested: Start charging at fifteen per cent. above the normal rate, maintaining this rate until the voltage reaches approximately 2.5 volts per cell. At this point the current should be reduced to the normal rate and the charge continued until the voltage stops rising.

"The general behavior of a battery on charge is as follows:—When the charging current is first applied the voltage of the battery rises immediately to about 2.15 volts per cell. During the first hour

of the charge the voltage rises rapidly until it reaches about 2.25 volts per cell. As the charge progresses, a very gradual rise is observed, until at about 2.45 volts per cell, a sudden jump is taken to nearly the maximum value, at which point the voltage remains practically constant, with both positive and negative plates giving off gas freely while the solution is perfectly clear. The evolution of gas usually begins at about 2.3 volts per cell, the bubbles gradually increasing in size as the cell becomes fully charged. Under ordinary operating conditions a battery may be considered fully charged when the voltage reaches a constant value, but at least once a week this method of determining the state of charge should not be relied on.

"There are three ways of determining when a battery is fully charged:

1—By the voltage reaching a constant value.

2—By the color of the battery plates.

3—By the specific gravity reaching a maximum constant value.

"It is very important that the battery be fully charged, but it is just as important that it be not overcharged. In the same way that the voltage reaches a maximum constant value, so will the specific gravity of the electrolyte, and readings of the individual cells of the battery in use should always be taken at least once a week with a hydrometer. These readings will act as a check on the voltage and, while it is not necessary to take them every time the battery is charged, it is very important that it be done frequently.

"The time required for the charge is, of course, variable and will depend upon the condition of the battery when the charge is started. In general, it may be assumed that about 20 per cent. more charge is required than discharge obtained. At least once in every two weeks the battery should be given an overcharge. To do this, charge the battery at the normal rate until the voltage reaches a constant value. At this point drop the charging current to about one-half the normal rate and continue to charge for three or four hours. While doing this it will be noticed that the specific gravity of the electrolyte will continue to rise for an hour, or even longer, after the voltage has become practically steady. This overcharge should be continued until the specific gravity becomes stationary.

"If, in case of an emergency, it becomes necessary to charge more quickly than usual, the charge may be started at about twice the normal rate and continued until the battery commences to gas and the voltage reaches 2.6 volts per cell. At this point the electrolyte will have a milky appearance and the battery will be gassing very freely. The charge should then be lowered to about 1.5 times the normal rate and the charge continued until the voltage again rises to 2.6 volts per cell, when the charging current should again be lowered. This proportionate reduction should be made every time the voltage reaches 2.6 per cell until the normal rate is reached, when the charge can be continued to the end in the usual manner. Great care must be taken not to overcharge excessively at a high rate, as this causes rapid shedding of the active material. At least once a week is often enough for an overcharge, provided the battery is in constant use. If the battery is only used spasmodically, or is kept floating on the line for an emergency, it is a good plan to discharge the battery at least once every two weeks, and then overcharge.

"The temperature of the battery must never be allowed to exceed 100 degrees F., the cells near the middle of the battery being used as a guide. If the temperature is found to be rising too close to the limit, the charge should be lowered or stopped. Experience has shown that the best results, both when charging and discharging, are obtained when the temperature is between 70 and 90 degrees F. A considerably lower temperature will materially reduce the available capacity, this reduction being regained with the return to normal temperature. If the battery gives its full rated capacity at 70 degrees F., at 30 degrees it will give about 76 per cent. of its capacity, while at 90 degrees it will give about 112 per cent. Low temperature never injures a battery but, on the contrary, if

the temperature be maintained for any length of time above the normal, the wear on the plates is excessive.

"The level of the surface of the electrolyte should be at least one inch above the top of the plates in the cell. When fully charged, the specific gravity of the acid in the majority of the lead batteries is from 1.200 to 1.225. Whenever a battery is given an overcharge, the specific gravity should be tested and adjusted. In making this adjustment, it should always be remembered that it is to be done towards the end of the charge and while the charging current is on. Should the specific gravity in some of the cells be lower than the majority, it is a better plan to charge these cells separately by cutting them clear from the battery and charging them separately at a low rate. When the cells are large and connected up permanently in series and it becomes necessary to charge a single cell to bring it up to condition, two wires may be run to the terminals of this cell from a separate source of current and the cell charged independently. If the gravity of a cell increases, it is a sign that this particular cell has, for some reason or other, been run down lower than its fellows and needs additional charging. If, however, the gravity does not come up and the temperature does not increase with charge, extra acid should be added. It is seldom necessary to add acid to a cell to bring up gravity (that is, gravity 30 or 40 degrees below normal). Never add acid until the cause of lowness is determined. With a battery in normal condition, the acid will usually be found to be high in gravity and water should be added to make up for the electrolyte lost by evaporation and gassing. This water should always be introduced into the cell at the bottom by a hose, or lead pipe, as the water will, if poured in, float on top and mix very slowly, since water is lighter than the acid."

The principal causes of trouble in a battery are loss of capacity, fracture and buckling of plates, sulphation of plates, reversal of cells, and impurities in the electrolyte. Loss of capacity is due to internal short circuits and the latter are usually caused by a bridging of the active material between adjacent plates or a filling of the bottom of the jar with sediment sufficient to reach the bottom of the plates. Their presence is indicated by the failure of the voltage to come up on charge, non-appearance of gas at the end of the charge, muddy solution, and a temperature above normal. Bridging between the plates can be removed readily by passing a strip of wood or glass between them. The removal of a deposit of sediment is more difficult. The best method is to separate the cells after the battery has been fully charged at a low rate, remove and wash thoroughly the elements, decant carefully the acid for use again, and flush the sediment out of the jars with pure water. In case the elements are too large to be removed readily, the sediment should be stirred up, the contents of the jars pumped out, and the jars then flushed with water. The sediment can be allowed to settle in another vessel and the acid decanted and used again. After cleaning, the battery should be charged for about 12 hours at normal rate until the voltage is at a maximum and then discharged to see that the voltage of all the cells is the same. Low cells should be charged separately until brought up to the voltage of the others.

Fracture and buckling are due to overdischarge, too rapid discharge, or defective plates. Shedding of the active material usually accompanies fracture and buckling. The remedies for the first two causes of this condition mentioned are obvious; for the third there is no remedy. Charging should seldom be done above 2.5 volts per cell and discharging never above 1.8 volts per cell.

Sulphation of plates, caused by overdischarge or excessive discharge rates, is usually indicated by a whitish appearance of the plates and a low specific gravity of the solution. The sulphate is gradually reduced by charging at about half the normal rate for from 40 to 90 hours, but several cycles of charge and discharge are necessary to bring the battery up to its full capacity. The battery plates should be carefully watched for sulphating and if they begin to turn lighter than normal, the sulphated cells

should be given a good overcharge. Discharged cells should not stand idle for any length of time on account of their tendency to sulphating.

Reversal of a cell seldom happens except when a cell has lost some of its capacity through accident or defect and then only when discharge has been carried so low that it is completely discharged before the other cells of the battery. The remedy is to remove the cause of loss of capacity, which may be due to bridging of the active material or to sediment, and then charge the cell separately up to normal condition.

Impurities in the electrolyte are indicated by disintegration of the plates, low voltage and decreased capacity, and are usually due to the presence of iron or chlorine. The presence of these elements in the electrolyte can be detected by the ordinary chemical tests. Nothing but a thorough cleaning will remedy the trouble.

"If the battery is to be put out of commission for two or three months, it should not be allowed to stand in the electrolyte unless a small charge and discharge can be given at least once a week. It should be slowly charged until full, then discharged at the normal rate for two hours. After this the electrolyte should be drawn off and pure water immediately put in the tanks. Continue the discharge at about one-half the normal rate until the voltage reaches about 0.5 of a volt. To do this it will probably be necessary to short-circuit the individual cells. The plates should then be washed thoroughly by using a hose on each element, then soaked in running water for 24 hours and allowed to dry. When put in commission again, pour in the electrolyte and give a long over-charge."

BENZOL AS AN AUTOMOBILE FUEL.

RESULTS OF A LARGE NUMBER OF TESTS ON A PANHARD-LEVASSOR MOTOR.

A. Grebel—Société des Ingenieurs Civils de France.

THE utility of benzol as a fuel for automobiles has recently been made the subject of two papers by M. A. Grebel, the first a discussion of the relative merits of benzol and gasoline, published in *Le Génie Civil* for June 13, and the second a very comprehensive paper covering thoroughly the whole subject, read before the Société des Ingenieurs Civils de France and published in the *Mémoires* for May. The following notes are taken from these papers.

Almost all benzol is produced as a by-product in the manufacture of coke, the process of extraction from the waste gases consisting of dissolving the crude benzol in heavy oils and later recovering it from the solution by distillation. It is then rectified by the removal of carbon bisulphide, tar, naphtaline, and other impurities and a final purification is obtained by washing with acids, soda, and other reagents. If the benzol is intended for use in automobile motors, this purification must be very carefully performed. If it is improperly carried out tarry products are left which interfere with the proper working of the carbureter and give rise to obnoxious and corrosive fumes. About 5 kilograms of rectified benzol are recovered per ton of coal coked. In the present state of the industry, France, Germany, England and Belgium produce large quantities of benzol annually but the amount could be largely increased in all countries so that the present price of from 25 to 28 francs per hectolitre (about 20 cents per gallon) could be maintained even though the demand were to increase to very large proportions.

The comparative physical properties of benzol and gasoline are as follows:

	Benzol.	Gasoline.
Density	.885	.700
	Calories per kilogram.	
Calorific power	10,033	11,464
	Calories per litre.	
	8,879	8,025
	Degrees C.	
Freezing point	—6 to —8	—100
Quantities of fuel added to 1	Grams.	
litre of air at 0° C. and 760	.09615	.08434
mm. for theoretically com-	Cubic centimetres.	
plete combustion	.10864	.1205
Vapor tension at 20° C.	122	296
	Degrees C.	
Temperature of boiling	81	50

The close similarity between benzol and gasoline has been the cause of many disappointments and vexations. It has led to the belief that benzol could be simply substituted for gasoline without any difficulty, and it must be admitted that by accident certain motors have worked well for a time within certain narrow limits of speed. In cases where bad results have been obtained, however, they have been hastily and erroneously attributed to the fuel itself. Benzol indeed presents many points of similarity to gasoline but it is distinguished from it by various characteristics of which account must be taken in the design of carbureters, the regulation of ignition, etc.

The principal charge made against benzol is that it causes fouling, but the black smoke, the odor of burned gases and the fouling are due entirely to imperfect combustion. M. Grebel has made upwards of 200 tests on a Panhard-Levassor motor and has never encountered any fouling except when testing a benzol only 50 per cent. pure. It is an easy matter to prevent fouling because, in order that a deposit of soot may be formed, it is necessary that the proportion of benzol in the fuel should be raised to double that theoretically necessary for complete combustion. Many carbureters, however, make an explosive mixture imperfect to a degree that would be believed impossible without the striking evidence of analysis of the waste gases. The influence of the mixture on the efficiency of the benzol motor cannot be too strongly emphasized. Even when the exhaust gases are colorless and odorless and the motor seems to be working perfectly, the combustion and consequently the efficiency may be relatively poor.

M. Grebel's investigations have shown that the minimum specific consumption corresponds to a percentage of carbon dioxide in the exhaust gases of 14 in the case of gasoline, and 17 in the case of benzol, without excess of oxygen and without carbon monoxide. These are the highest percentages attainable in practice, though the theoretical percentages for complete combustion are 14.4 and 17.4 respectively.

The maximum of power is found at about the point of maximum explosibility which corresponds to the highest explosive pressure. This is given by a mixture slightly richer in benzol than the mixture for theoretically complete combustion. With the mixture giving maximum power, about 1½ per cent. of carbon monoxide is found in the burned gases.

In M. Grebel's tests the minimum of consumption has always been found to be attained when the air actually introduced bears to the air theoretically necessary the proportion of 1 to 1.1. This differs considerably from the proportion of 1.3 to 1.7 recommended some years ago by Sorel and adhered to by many builders through fear of a shortage of air under certain conditions.

A NEW METHOD OF TESTING HARDNESS.

A DISCUSSION OF THE THEORY AND APPLICATIONS OF THE SHORE SCLEROSCOPE.

J. F. Springer—The Iron Age.

UNTIL recently the only available means of measuring the hardness of metals with any degree of accuracy have been the Brinell ball test and determination of the magnetic capacity. A method has now been developed which measures hardness by determining the recuperative power of a metal subjected to an instantaneous blow which strains it beyond the elastic limit. The instrument used and the theory on which it is based are discussed by Mr. J. F. Springer in *The Iron Age* for August 27, from which we take the following extracts.

"The question what is to be understood by hardness is by no means an easy one. We say that brass is hard and lead is soft. The file gives us reliable information as to this. But when we turn to manganese self-hardening steel and pure carbon tool steel, we may

find that a specimen of the alloy steel offers the same resistance to the file as the pure carbon steel, but that the alloy is really softer. Some other quality of the alloy steel is furnishing resistance to the file in addition to hardness. This appears to be the toughness. It would seem that particles of the alloy yield somewhat to the file at first, but resist actual separation, producing a total resistance to the file equal to that afforded by the pure steel. It appears thus as if time were a factor, the particles of the alloy suffering a slight displacement which occupies time, but in the end resisting determinedly any further displacement. This is the case also with tar asphaltum. A sharp, quick blow will shatter a block instantly into fragments, whereas it will yield under the mere weight of the hammer if time be allowed. Sealing wax also is comparatively hard for instantaneous impacts of tools, but soft for slow ones.

"Let us provisionally define hardness, then, as the resistance set up to instantaneous displacements. If displacements can be effected with an instantaneous effort which would fail if slowly operating, it would appear in the latter case that a second quality is assisting, namely, toughness. Perhaps we may say that the degree of hardness varies with the recuperative power of a substance subjected to instantaneous and permanent deformation.

"About a century ago a method of testing for hardness by means of the diamond was proposed in Germany. This process of scratching with a diamond point was improved in England and proved of value, especially, it would seem, where toughness did not enter. With tough substances, however, the diamond, like the file, seems to have failed. A more modern method is that developed under the name of the Brinell test. This consists essentially in pressing a steel ball into the specimen and then measuring the depth or diameter of the permanent displacement effected. This is, no doubt, a practical improvement over the file and the diamond point. The deeper the depression, other things being kept equal, the softer the metal is judged to be. As the pressure is applied slowly, it would seem doubtful, however, that this process would be successful in eliminating the element of toughness.

"Recently an invention by Albert F. Shore has been put upon the market. If the provisional definitions heretofore given be accepted, this new instrument would seem to supply the means of effecting accurate and scientifically correct measurements of hardness, for with it an instantaneous blow is struck, and the recuperative power of the specimen is then measured by determining the extent of the rebound of the striking hammer, the elastic limit of the metal being tested having been exceeded."

The instrument consists essentially of a glass tube, open at the bottom, on the back of which is a graduated scale running from 0 to 140. The tube serves to guide the falling hammer which is the most important element of the instrument. The hammer is sucked up to the top of the tube by compressing a rubber bulb and a suitable device is provided for holding it there until it is desired to strike the blow. Release is obtained by pressing another rubber bulb. The hammer, a small piece of steel fitting smoothly in the bore of the tube, falls perfectly freely. On striking the specimen under test it rebounds, and the amount of the rebound as read upon the scale is considered a numerical statement of the degree of hardness. The body of the hammer is cylindrical but the striking end tapers to a sharp point. The blow compared with the area of impact is very large, being calculated to be no less than 75,000 pounds per square inch. Tests are always made, of course, with the hammer falling vertically in the tube, and levelling screws and plumb rods are provided for the purposes of adjustment.

"Now, if the definition of hardness as the recuperative energy instantaneously available upon permanent deformation be correct, then the scleroscope would appear to afford a reliable measure. For if the recuperative energy is nil the rebound is zero and is so indicated on the scale. If the recuperative energy in one case is double that in another, then the amount of work accomplished in the

former case will be double that in the latter. But a rebound through double the space means double the work accomplished. So that when the scleroscope records a rebound of 90 graduations in one case and 45 in another, these indicate recuperative energies in the same ratio of 2 to 1. Now this seems to contrast with the Brinell indentations. For even granting that the latter vary inversely with the hardness, it can scarcely be contended that an indentation of double the concave area means double the hardness. In fact, much more than double the energy is required to produce double the area. Where is the guarantee that the rate is proportional to the decrease in hardness?"

The instrument is applicable to any and all metals. Among other important applications, it offers an easy and convenient means of determining the relative hardness of machine parts in frictional contact, and also of determining variations in hardness at different points of the surface of a specimen. It may also be applied to testing hardened steels for crystalline structure and from the results already obtained it is expected that by its use metal cutting will be put on a much more scientific basis. A further use is for testing and inspecting product before shipment. Comparative tests by the Brinell and scleroscope methods show fairly close agreement in results.

THE JAPANESE MERCHANT MARINE.

A STATISTICAL REVIEW OF THE DEVELOPMENT OF SHIPOWNING IN JAPAN.

Engineering.

WITHIN the last few months a statement by no less an authority than Mr. James J. Hill, to the effect that the American and Canadian steamship lines engaged in the Pacific carrying trade are being gradually driven out of business owing to their inability to meet the competition of the Japanese subsidized lines, has drawn attention to the remarkable development of Japan's mercantile marine. The rapidity of this development is well shown in a statistical review in *Engineering* for August 14, from which we take the following notes. In a future issue we shall present an abstract of a similar review of the development of the shipbuilding industry, which *Enginering* promises in the article here abstracted.

"Shipowning in Japan, on a scale comparable with the shipping work of Western lands, is necessarily a matter of very modern development. Whatever the country may have done or attempted to do in its earlier history, the year 1639 marked a complete cessation of foreign trade; the size of home-built ships was, about that time, limited by law in order to prevent them from venturing too far from their own shores; and amongst the other countries of the world, China, Korea, and Holland were alone permitted to trade with Japan by sending their ships to Japanese ports. The prohibition of foreign trade thus enacted extended over a period of fully 220 years; the reopening of the country in 1853 necessitated an entire change of policy, which, keenly desired, was not so readily effected; the need, however, was emphatically declared by the Shogun's Government in 1861, when permission was first given for the engagement of Japanese ships in foreign trade. This permission was so far taken advantage of that, in 1868, just after the commencement in 1867 of the present era of Meiji, there existed forty-six merchant vessels, of 17,000 tons, and of 'foreign' construction; some of these vessels were steamers, the others sailing vessels; some were built in Japan, and the rest purchased from abroad.

"In the early days of Meiji an intimation was repeatedly made by the Government that such 'foreign' vessels were allowed, and that protection would be afforded by the Government to Japanese shipping enterprises with foreign countries. In 1870 the first large steamship company was established, under the name of the Kwaiso Kwaisha (the

Transport Company); this company, under Government auspices, underwent various changes, its name in time becoming Nihonkoku Yubin Jokisen Kwaisha (Japan Mail Steamship Company). In 1871 a rival company appeared on the scene, organised by the late Baron Yataro Iwasaki, under the name of Mitsu Bishi Kwaisha (Three Diamonds Company, so called from the crest and flag adopted by the new organisation). This company did such excellent work for the Government during the military expedition to Formosa in 1873-4 that it was deemed advisable by the authorities to lean largely upon it for support, wind up the affairs of the officially directed company, and close the keen competition that had sprung up between the two; the ships of the Nihonkoku Yubin Jokisen Kwaisha were, therefore, in 1876, transferred to the Mitsu Bishi Kwaisha, and the latter company strengthened in other ways. The combined fleet of this company then consisted of forty-two ships, six of them sailing vessels, and the remainder steamers of various sizes, twelve exceeding 1000 in gross tonnage. In 1882 the company further strengthened itself and added steamers capable of performing the functions of both transports and cruisers, a stipulation being made by the Government, in return for privileges conceded, that it was to have the use of the ships, in case of need, on the payment of some 5 yen* per ton per month. In 1882 the gross tonnage owned by the Mitsu Bishi Kwaisha was 22,000. In the same year, with the object of increasing the mercantile marine, Government support was afforded to a new company, the Kyodo Unyu Kwaisha (Union Transportation Company), so that two companies, rivals along certain lines, were again in the field, both obtaining assistance from the State funds. This lasted until 1885, when an amalgamation was made, and the now powerful Nippon Yusen Kabushiki Kwaisha (Japan Mail Steamship Company) formed by the combination of the two.

"To the newly-formed Nippon Yusen Company a dividend of 8 per cent. was guaranteed by the State; but this was commuted, in 1887, to an annual subsidy of 800,000 yen. In the years previous to the war with China this enterprising company made steady progress, doing most of the coastwise trade, and also the trade with the nearer foreign ports; in 1892 it established a line to Bombay, and performed, moreover, frequent service to Australia in the one direction, and to Hawaii in the other. In the Chinese war of 1894 the large steamers of the company were all requisitioned by the Government, and many more were purchased by the company both for Government needs and to maintain its own trade; the services were very efficiently rendered and the company became correspondingly stronger. On the conclusion of the war, and encouraged by the new bounties, to which reference will be made in a subsequent article, the Nippon Yusen Kaisha resolved on a large expansion of its work and influence; it raised its capital to 22,000,000 yen, and established regular services to America, Europe, and Australia, in addition to the existing line to Bombay. Large steamers, twelve of them exceeding 6000 tons, were ordered, mostly from the Clyde, though with the reserve of a sufficient number for Japanese construction to develop and advance the art of shipbuilding at home. Since that date the company has frequently added to its fleet, its new ships being, in recent years, all built at home—*i. e.*, in Japan—although these have been supplemented by the ships purchased during the war with Russia and the captured ships taken over from the Government after the termination of the war. Among those recently built in Japan, the Hitachi Maru (second of the name), 6715 gross tons, for the European service; the Nikko Maru, 5539 tons, for the Australian service; the Tango Maru, 7463 tons, for the American service; and the six ships of the Kamo class, each of 8770 tons, now completing, and to be employed as general traders, may be specially mentioned."

When the latter are completed, the company's fleet will consist of 85 vessels of a total tonnage of 313,627. The

* Yen = 2s. 0.582d., or 49.8 cents.

capital of the company is 22 million yen.

"In 1884 the Osaka Shosen Kabushiki Kwaisha (Osaka Mercantile Steamship Company) was established, and received from the first some measure of Government support. Many coasting services have been, and are, performed by this company, whose operations are extended also to Formosa and the costal trade of that island, to Korea and to Hong Kong, and to various Chinese ports." The capitalization is 16½ million yen. The company now owns 107 vessels of a total tonnage of 107,013, but it "is on the eve of development in the direction of the establishment of a regular freight service with America, for which purpose six steamers (each of 6000 gross tons) are at present under construction in Japanese shipyards.

"The Toyo Kisen Kabushiki Kwaisha (Oriental Steamship Company) was established in 1896. Its first three steamers were built in England, and created a Japanese service with San Francisco, making occasional runs to Mexico and other ports." It now owns 8 vessels of 53,065 gross tonnage. Recent developments have necessitated an increase of capital to 13 million yen. "The two great strides this company is making at the present time are, on the one hand, the construction of the Tenyo Maru (now running), the Chiyo Maru, and another steamer, all of 13,500 gross tons, and furnished with Parsons turbines, to give a speed of 19 knots; and, on the other hand, the use of oil fuel, both in the large vessels just mentioned, and in the other branches of the company's work. In this connection, the company has recently purchased three tank steamers of Tyne build, and is building two more (of 9320 gross tons each) at Nagasaki. The three turbine steamers are for the Hong Kong, Yokohama, and San Francisco run.

"The three large companies thus far referred to have a certain importance from another circumstance not yet mentioned—viz., that they receive each year definite subsidies for prescribed services which they undertake. Until last year there were three other small companies doing regular services round the coasts of Japan, to, from, and in China, and to and from Korea, which were the beneficiaries of similar subsidies. These companies were the Konan Kisen K. K., the Daito Kisen K. K,. and the Oya Shosen Goshi Kwaisha. Last year the two former of these companies passed into a new combination, together with some vessels hitherto belonging to the Osaka Shosen K. K. and the Nippon Yusen Kwaisha.

"This new company is styled the Nisshin Kisen K. K., and possesses fourteen steamers in all, with an aggregate gross tonnage of 29,347 tons. The Oya Shosen K. K. has five steamers, of 8415 tons. The other most important shipowners of the country, whether companies or individuals, are the following:

Mitsu Bishi Goshi Kwaisha, with 13 steamers, of 13,292 aggregate gross tons.
Mitsui Bussan Gomei Kwaisha, with 29 steamers, of 28,827 aggregate gross tons.
Ojiro Goshi Kwaisha, with 5 steamers, of 12,498 aggregate gross tons.
Tatsuura Shokwai, with 9 steamers, of 17,289 gross tons.
Ukon Gonyemon, with 7 steamers, of 16,108 gross tons.
Oaki Kikusaburo, with 14 steamers, of 22,257 gross tons.
Hiromi Nisaburo, with 10 steamers, of 24,545 gross tons.

"A summary of the total registered and unregistered ships and tonnage of the country built in 'foreign' style, as held at various dates, is as follows:—

	Steamers.		Sailing Vessels.		Steamers and Sailing Vessels.	
Date.	No.	Net Tons.	No.	Net Tons.	No.	Net Tons.
1868	....	.....	....	.....	46	17,000
1875	149	42,304	44	8,834	193	51,138
1880	210	41,215	329	48,094	539	89,309
1885	461	59,613	509	52,643	970	112,256
1890	586	93,812	865	51,880	1451	145,692
	Gross Tons.		Gross Tons.		Gross Tons.	
1895	827	341,369	702	44,794	1529	386,163
1900	1329	543,365	3850	320,572	5179	763,937
1905	1988	939,749	4132	336,571	6120	1,276,320
1906	2081	1,041,311	4497	353,434	6578	1,394,745

Excluding all vessels below 100 tons, the figures for some years past become:—

	Steamers.		Sailing Vessels.		Steamers and Sailing Vessels.	
Date.	No.	Gross Tons.	No.	Gross Tons.	No.	Gross Tons.
1890	112	26,815	81	19,853	193	46,658
1895	274	194,234	71	19,095	345	213,329
1900	510	516,292	1108	154,663	1618	661,955
1905	740	901,225	1219	168,338	1959	1,069,563
1906	799	993,302	1255	172,279	2054	1,165,581
1907	848	1,066,432	1296	178,112	2144	1,244,544

This list neglects junks, of which there were in 1906 21,920, of a gross tonnage of 261,000.

THE RUSSIAN PLATINUM INDUSTRY.

A PROPOSAL TO MAKE THE RUSSIAN PLATINUM INDUSTRY A NATIONAL MONOPOLY UNDER THE DIRECTION OF THE IMPERIAL BANK.

The Mining Journal.

THE issue of *The Mining Journal* for July 25 contains an abstract translation of a report recently submitted to the Russian Minister of Finance, in which the nationalization of the platinum industry is strongly advocated by Mr. P. M. Utyakoff, one of the Ural producers. Russia, as is well known, produces 95 per cent. of the world's supply of platinum and it might be expected that the platinum industry would be ruled from that country. On the contrary, however, the Russian business is almost wholly in the hands of foreign capitalists and this works to the disadvantage of the native producers in a variety of ways. Notwithstanding the facts that no satisfactory substitute has been found for platinum, that its use is increasing annually, and that no deposits have been found to compete with the Ural fields which are rapidly becoming exhausted, the price of the metal is subject to very wide fluctuations, due not to variations in the demand but entirely to speculation in foreign markets. The producers, under these conditions, are unable properly to organize their production, to institute a detailed system of prospecting, to install and organize proper extraction and manufacturing plants, or intelligently and economically to take advantage of the ground of the Urals. The platinum treating industry is similarly affected by the unsettled conditions. The three small treating plants in Russia manufacture only 7 per cent. of the world's supply of refined platinum, not enough for the needs of the country. Hence the agitation for a Government monopoly along the lines outlined below.

"Platinum ore, as is known, besides its platinum content, contains associated precious metals such as osmium, iridium, rhodium, rutinium, and palladium; on the average, there is about 3 per cent. of these metals in the ore. At the present time these metals are exported for nothing. The crude platinum is sold per percentage of content of pure platinum metal, without taking into account the associated precious metals contained in it. Although the quantity of metallic associates of platinum (which are worth even more than the platinum itself) is not great, nevertheless, if we take into account that the Russian refining factories work up now no more than 10 poods of platinum, and that the country produces 400 poods in the year, one can grasp the loss that the national platinum industry suffers in this respect alone. Besides this, the difference between the price of the crude platinum and the manufactures therefrom is very great, and is entirely lost to the country. It is gained by the foreigner.

"Resulting from the foregoing, the author suggests the measures to be taken as follows: the Government, through the Imperial Bank, should buy the platinum at a minimum established price, but not below a level that would pay for working poor deposits. With modern technical and economic conditions the price, according to the estimate of Mr. Utyakoff, could be fixed at 29,000 roubles per 100 per cent. metallic platinum. Direct sales abroad should be prohibited, and all the platinum produced in Russia, both refined and crude, should be accepted by the Imperial Bank. By taking delivery of the crude platinum only the quantity of pure platinum content of the ore could be calculated, without reference to the associated precious metals. The bank would sell the metal in a refined form with the object of keeping the associated precious metals in the country. Every half-year auctions would be held at the prices existing in 1906—namely, 42,000 roubles per pood of refined metal. Half or the difference between the purchase and sale price would go to the bank and the other half to the industry. In this way the bank would make not less than 2,500,000 roubles from the an-

nual production of platinum. By fixing the price and not letting it go under 42,000 roubles per pood, the desired level would be reached. It may be urged that the foreign platinum syndicate, possessing reserves, would not abdicate its position without a struggle, and would put its platinum on the market in such quantities and at such prices that the platinum belonging to the bank would be unsaleable. That is a groundless fear. The stocks of metal held by the foreigners cannot be great, and in the course of the first half-year they might put 200 poods on the market in order to obviate a platinum famine. Being convinced that the bank was determined to continue the purchase and sale of platinum, the syndicate would not continue to sell at a low price goods that it could not replace. It would not be difficult for the bank to regulate the price of platinum by limiting the deliveries. The amount of working capital would hardly exceed the annual production of platinum—*i. e.*, about 10,000,000 roubles. The cost would be insignificant in comparison with the profits which it yields.

"If the monopolization of the platinum industry were recognised as impracticable on the basis named, the author still thinks that the Government could get the benefit of the industry by undertaking the regulation of the price of the metal, which could be easily done as follows: During a fall in price, let us suppose under eight roubles per solotnik, the bank would accept platinum at the current price, and hold it in stock, and when the price reaches eight roubles it could cease buying and put what it has on the market. A price limit could be fixed every year conformably with the state of the market, and the difference between the buying and the selling price the bank would (just as in the case of the actual monopoly supposed above) divide between the Treasury and the industry.

"As to refining the metal, that presents no technical difficulties, even on a large scale. But for this, in any case, there is no need to build Treasury refineries, as some have suggested. The existing refineries in Russia can deal with it quite easily, not only as to the production, refining, separation of the associated precious metals, but also in respect to the manufacture of all kinds of platinum goods."

THE DIRECT PRODUCTION OF COPPER TUBES, SHEETS AND WIRE.

AN OUTLINE OF THE CENTRIFUGAL PROCESS FOR DIRECT ELECTRO-DEPOSITION FROM IMPURE COPPER.

Sherard O. Cowper-Cowles—Institution of Mechanical Engineers.

SINCE Elkington applied Faraday's law of electrolysis to the refining of copper in 1865, electro-metallurgists have been striving to devise a satisfactory commercial process which would do away with the smelting and mechanical treatment of copper after electrolytic refining and permit the direct production, by electro-deposition from impure copper, of sheets, tubes and wire having the physical properties of wrought copper. It was early discovered that the current density, or the rate at which copper is deposited, could be increased by circulating the electrolyte, or by moving the electrodes. In 1875 Wilde patented a process, based on this discovery, for depositing copper on iron rolls for textile printing purposes, in which an even deposit of copper was obtained by rotating the cathode, an iron cylinder, in the electrolyte which was itself agitated by means of a propeller. He failed, however to obtain a higher current density than 20 amperes per square foot. Later Elmore developed a process which consists of depositing sheets or tubes on horizontal mandrels, while agate burnishers travel continuously over the copper to consolidate it. Large works near Leeds, England, are engaged in the production of large tubes and cylinders by this process, but the current density cannot be increased beyond 30 amperes per square foot and the mechanical difficulties introduced by the burnishers are

considerable. For the agate burnishers in the Elmore process, Dumoulin substituted sheepskin, and it was claimed that a current density of 40 amperes per square foot could be obtained, but the process was not commercially successful. Other processes, proposed by Swan, Elmore and others, have attempted to increase the rate of deposit by impinging jets of the electrolyte against the cathode surface, but with little success. The latest development, the centrifugal process, invented some four years ago by Mr. Sherard O. Cowper-Coles differs in many respects from its predecessors and, according to a paper read by the inventor at the July meeting of the Institution of Mechanical Engineers, has proved much more successful than any of them. We present below an outline of the methods and results of the process as given in this paper.

"The author, when carrying out some experiments on the production of copper tubes and sheets by electro-deposition on rotating cathodes, observed that when the speed was greatly increased entirely new results were obtained, and that a current density of 200 amperes or more per square foot could be employed, the copper remaining smooth and having a tensile strength equal to the best rolled or drawn copper, and in some cases a tensile strength some 50 per cent. higher than that obtained by the ordinary process of casting and rolling, the tensile strength increasing with the rate of rotation of the mandrel. The result of revolving a mandrel at a comparatively high speed is that every molecule, as it is deposited, is burnished or rubbed down so as to produce a tough fibrous copper, the usual order of things being reversed, the present practice being to put the mechanical work into a mass of copper by rolling or drawing instead of treating each molecule separately. This observation led to further experiments, which resulted in evolving the process now known as the centrifugal copper process for the manufacture of sheets, tubes, and wire.

"After a long series of experiments had been made to determine the best composition for the electrolyte and the most economical current density to employ, the critical speed was accurately determined by means of revolving cathodes in the form of cones. By observing the point at which the copper remains smooth, and by measuring the circumference of the cone at that point and multiplying it by the number of rotations per minute, the critical speed is readily determined; 200 amperes per square foot is found to be the most economical current density, although a current density up to 500 amperes per square foot can be employed by increasing the rate of rotation, but the increased cost due to increased voltage renders such a current impracticable for ordinary commercial work.

"One of the chief difficulties inherent in any electrolytic or wet process for the production of copper tubes and sheets is having any working parts, such as bearings, in an acid copper sulphate solution, and this was one of the first troubles encountered when working the centrifugal process on a commercial scale. This difficulty was eventually overcome by constructing vats in the form of an annular ring. By such an arrangement all working parts are outside the vat and do not come into contact with the electrolyte, so that the bearings can be lubricated in the ordinary way; only the actual face of the mandrel on which the copper is to be deposited is immersed in the electrolyte. The cathode consists of a steel or cast-iron cylinder closed at one end, to which is attached on the inside a steel rod projecting below the edge of the mandrel to guide it into position; the cylinder can be 5 or 6 feet in diameter or even larger so as to produce a copper sheet of say 20 feet long by 4 or 5 feet broad. Anodes composed of crude copper are placed around the mandrel with intervening spaces and are fed forward by suitable mechanical means as the copper dissolves away so as to keep the voltage constant.

"One great advantage of the centrifugal process is that a very low voltage is required even when employing a very high current density; for instance, only 0.8 of a volt is required at the terminals of the vat when working at a current

density of 200 amperes per square foot of cathode surface. The effect of revolving the cathode is five-fold; firstly, it keeps the electrolyte agitated, so that there is always a fresh supply of copper ions in proximity to the cathode; secondly, each molecule of copper as it is deposited on the cathode is burnished or rubbed down by means of the skin friction between the revolving cathode and the electrolyte; thirdly, the rotation prevents any foreign matter that may be in suspension in the electrolyte settling on the cathode and becoming entangled by further copper being deposited around or over it; fourthly, it brushes away any air bubbles on the cathode, which are the cause of nodules forming; and fifthly, the rotation of the cathode ensures the thickness of the copper being uniform even when a mandrel of say 8 feet in length is employed.

"The method of making tubes by the centrifugal process is as follows:—A mandrel somewhat smaller than the finished internal diameter of the tube is prepared by coating it with an adhesive coating of copper by first depositing copper upon the surface from an alkaline solution and then thickening it up in an acid solution, the surface being highly burnished and treated chemically to ensure the easy removal of the deposited tube. The mandrel thus prepared is then placed in a vat designed according to the diameter of the tube and its length. When the desired thickness has been obtained the mandrel is removed and placed in a horizontal or vertical lathe, and a round-faced roller run over the surface so as slightly to expand the deposited copper, which can then be readily drawn off.

"Copper sheets are prepared in a similar manner, the only difference being that the mandrels are of much larger diameter, and a narrow insulating strip is fitted down one side so that the sheet can be easily removed by inserting a tool under one of the edges of the deposited copper. It is no more costly by the centrifugal process to make thin sheets than thick ones; copper foil can be made in five minutes direct from crude copper.

"Copper tubes produced by this process without any drawing have given a maximum stress of 17 tons, and tubes after drawing have withstood a pressure of 3,000 pounds per square inch without showing any signs of distress. Sheets made without any rolling have given a maximum stress of 28 to 30 tons and more per square inch according to the peripheral speed at which the mandrels were revolved.

"The formation of copper trees and nodules was another difficulty that had to be overcome, but which has been reduced to a minimum in the centrifugal process, for the reason that impurities held in suspension in the electrolyte have no opportunity of settling on the cathode, and all gas bubbles are swept from the surface on which the copper is being deposited.

"The percentage of free acid employed in the centrifugal process is high, amounting to 12 or 13 per cent. The electrolyte, the usual composition of which is 12.5 per cent. of copper-sulphate and 13 per cent. of sulphuric acid at a temperature of 40 degrees C., is kept in the cupric state and the impurities in suspension separated by means of a centrifugal filter provided with arc lights and an atomizer for breaking the solution up into a fine spray. It has been found that by subjecting the solution to a strong light the impurities are more easily precipitated, and the solution is kept in the cupric state.

"The production of copper wire by electrolytic means is a more difficult problem than the production of copper tubes and sheets. . . . . A mandrel similar to that used for making copper sheets is employed, around which a spiral scratch is made, the pitch being determined by the size of wire required. The effect of the spiral scratch (which need only be very light but must be angular), is to cause the crystalline structure of the copper to form a cleavage plane. The copper divides exactly at the apex of the scratch, that is, the copper deposited in the scratch is equally divided and forms a small V-shaped fin on two sides of the copper strip. If the scratch is not angular, but rounded at the base, the copper will not divide, as the crystals

are radial. After the desired thickness has been obtained, approximating the pitch of the spiral scratch, the mandrel is removed from the depositing cell and placed in a vertical position on a lathe, and the copper strip is unwound at an angle of about 45 degrees to the face of the mandrel. During the process of unwinding, the small fin or burr is removed by passing the wire through a suitable die and then through a wire-drawing machine provided with three or more draw-plates to reduce the strip to the desired diameter. By employing a mandrel of 6 or 7 feet in diameter, lengths of wire 4 or 5 miles long can be made in one operation.

"The advantages of an electrolytic process as compared to a smelting process are many, and the day is not far distant when copper will no doubt be leached direct from the ore and electrolyzed with insoluble anodes, to produce finished copper sheets and tubes in one operation direct from the ore without the intermediate process of smelting and refining.

"The centrifugal process is a step in this direction, as it is capable of depositing copper from its solutions by using insoluble anodes in the form of finished tubes or sheets in one operation. The centrifugal process is at least ten times faster than any existing electrolytic process, and a high current density can be employed without deteriorating the quality of the copper. There is no risk of lamination, as no burnishers are employed. The plant is simple and free from mechanical complications, and the amount of copper locked up for a given output is small compared to other processes. The process is of interest to mechanical engineers as it conclusively proves that to get a high tensile strength in metals combined with ductility, it is not essential to put a large amount of work into the metals as hitherto has been considered necessary, by the processes of swaging, rolling, or drawing, but that a very small amount of energy will suffice when applied in the manner described"

With blister copper at £65 per ton, a ton of copper sheets can be produced by the centrifugal process at a total cost of £70, as against £72 10s. by the ordinary process of refining, casting and rolling. At the same price for blister copper, wire can be produced at a total cost of £70 per ton, as against £77 by the ordinary methods. The copper produced is ordinarily about 99.976 per cent. pure. A plant to produce 10,000 tons of sheets, tubes and wire per year, is estimated to cost £104,000, and it is estimated that in such an installation, finished material could be produced at £2 16s. 6d. per ton.

THE EFFECT OF HUMIDITY ON MINE EXPLOSIONS.

THE INFLUENCE OF THE HYGROMETRIC CONDITION OF THE AIR CURRENTS ON THE FORMATION AND IGNITION OF DUST AND GAS.

Carl Scholz—American Institute of Mining Engineers.

IN recent numbers of THE ENGINEERING MAGAZINE we have reviewed in these columns three papers on the important subject of the causes and prevention of colliery explosions, dealing, respectively, with their relation to seismic disturbances, the effects of dust, and the dangers attending the use of explosives. We present in abstract below another highly interesting contribution to this discussion, from a paper to be read by Mr. Carl Scholz at the Autumn meeting of the American Institute of Mining Engineers in progress as this issue appears, and published in the *Bulletin* for July. From observations extending over several years Mr. Scholz has been led to believe that altitude and climatic conditions exert a much more important influence on mine explosions than is generally supposed. In his paper he outlines the data on which his theory is based and suggests practical means of minimizing by artificial means the dangerous conditions caused by lack of moisture in the air.

"The striking features developed by these investigations are:

1. Explosions occur more frequently in the colder months of the year; the colder the winter the more frequent the explosions. If a certain district has extremely cold weather and other sections of the country are comparatively warm, the latter sections are freer from explosions.

2. Mining fields located in higher altitudes are more productive of explosions than those at lower elevations.

3. The hygrometric condition of the atmosphere has the greatest effect upon the cause of explosions. . . . . .

"The mines of Oklahoma offer special facilities for the observation of the effect of climatic and hygrometric conditions upon explosions, because the coal is high in hydrocarbon and low in moisture; the outside temperature ranges from 90 degrees F. in the summer to 10 degrees F. in the winter, and the hygrometric condition has a wide range, because of the excessive rain in the summer, which is followed by a prolonged dry period in the fall and winter. The observations inside the mines are facilitated by the noticeable effect which humidity has upon the roof during the wet season and the number of explosions which usually occur during the cold, dry season. I therefore selected the mines in this field for a series of observations which were carried on during the past 18 months.

"The first purpose of these investigations was to stop the slacking of the roof, which occurs during the 'sweaty' season, beginning about May 1 and lasting until the middle of July. During this period a heavy deposit of moisture on the roof causes the slate to slack, especially on the in-take air-ways and near the place of in-take. On account of the high cost of timber, this condition considerably increases the production-cost. From August to November the mines became very dry, and are very dusty for the next three or four months, during which time explosions occur. One fortunate condition in this field is the fact that the veins are pitching, and the water usually runs along the entries, although the beneficial effect of this condition is not generally understood or appreciated.

"Observations indicate that when the outside temperature ranges from 75 degrees to 90 degrees F., the inside temperature fluctuates from 72 degrees to 76 degrees F. In the winter, when the outside temperature ranges from 30 degrees to 55 degrees F., the inside temperature ranges from 60 degrees to 64 degrees F. In the summer, when the warm-air current enters the mine, the temperature falls upon coming in contact with the cold ribs along the entries, and the excess vapor is deposited as sweat on the roof and the roadways, so that no dust exists. The mine, of course, becomes drier nearer the up-cast, since a part of the humidity is absorbed by the freshly-mined coal. In the winter, when the inside temperature is higher than that of the air outside, the cold ventilating current, upon warming and expanding, absorbs all the moisture available. If there is no water available, the relative humidity in the air-current is very low. For the purpose of illustrating this more clearly, the following data, representing actual readings, will be of interest:

"With an outside temperature of 80 degrees F. and relative humidity of 75 per cent., at a barometric pressure of 29.2 inches, a ventilating-current of 75,000 cubic feet per minute carries into the mine, invisibly suspended in the air, during a period of 24 hours, 15,200 gallons of water. Upon cooling to a temperature of 75 degrees F, not only would the mine-current be completely saturated, but there would be deposited in the mine nearly 1,000 gallons of water per day. In the winter, however, with a temperature of 32 degrees F. and a relative humidity of 95 per cent., upon entering the mine and warming to 62 degrees F., the relative humidity of the ventilating-current is diminished to 33 per cent., unless an opportunity is given for the air-current to absorb more moisture from running water or other sources. In order to saturate completely this warmed air-current of 75,000 cubic feet per minute, about 9,000 gallons of

water per day is required. This is the reason why dust is generated in the winter in the better-ventilated mines, and the assumption is well borne out by the accident at the Monongah mines, which had a ventilating efficiency of the highest order. The more cold air forced through a mine in the winter, the drier will that mine become; the more air forced into a mine in the summer, the more moisture will be deposited along the in-take entries, and where the roof is slate, the more difficulty will be experienced in keeping up the top. It is also well known that humidity in the air has an effect upon the ignition of gases, because the fine particles of water invisibly suspended in the atmosphere absorb much of the heat in combustion. For comparison, it may be said that an air-current of a temperature of 62 degrees F., fully saturated with moisture, requires approximately 7 per cent. more heat-units (British thermal units) than dry air to reach a temperature of 1,213 degrees F., which is the point of ignition of fire-damp.

"A water-spraying system, consisting of a number of small sprays distributed over the first half of the distance which the air-current traverses, will have the effect of preventing the formation of dust and moistening the gaseous mixture. The sprays should be placed near the roof, and discharge the water in the direction of the air-current. This arrangement will have an additional beneficial effect in mines generating much fire-damp, the descending water-spray serving to break up any stratification of gases that may exist in the entries. The proper quantity of water to be vaporized will depend upon altitude, climatic conditions and character of the coal. The only danger to be guarded against is the use of an excessive amount of water, which would result in cutting a slate roof; if coal or sand-rock prevails, no limit need be established, because, with the lower temperature in the mines in this country, the danger which was pointed out by the British Colliery Commission, that excessive humidity injuriously affects the health of the miner, does not exist, the temperature of the English mines being from 90 to 95 degrees F. . . . . .

"The advantage of a spray is that the vapor will break up stratification and mix the gases over the entire cross-section of the entry. This action can be repeated as often as necessary by the spacing of the sprays, and the requirements can easily be determined by hygrometer-readings and gas-tests. There would be no advantage in or necessity of operating these sprays during the summer, unless indicated by hygrometer-readings in very dry mines. . . . . The principal benefit derived from sprinkling water by means of water-boxes or hose-lines, as now generally practiced and recommended, is that moisture is provided for absorption by the dry mine-air. As far as the settling of dust is concerned, unless the sprinkling is very thorough and often repeated, the results are not satisfactory, because a deposit of coal-dust is impervious to water unless thoroughly mixed with it; a thin moist coat will form on the surface, beneath which the dust is as dry as ever. The cost of labor in this method of sprinkling is very high and the service performed is spasmodic, and unless constantly looked after by foremen or superintendents it is likely to be neglected. The advantage of a spraying-system is that, in addition to preventing the formation of dust, the sprays can be utilized to prevent stratification of gases at night or on idle days, and this advantage can be obtained at a cost of installation but little greater than that of the hose system, as it involves only the addition of spray-boxes at a cost of $2 each. There is no expense connected with this, because most mines employ pumpers on idle days and at nights, and the shaft pressure can be used in the sprays; or if this is not convenient, in most places some outside supply can be connected which will insure continuous operation. It is believed that the operation of such a spraying-system, by reason of the continuous and automatic protection which it furnishes to the mines, is the most economical, and at the same time the most important step which operators can take to safeguard their mines."

THE USE OF SUPERHEATED STEAM IN LOCOMOTIVES.

A DISCUSSION OF THE ECONOMIES AND ADVANTAGES SECURED BY THE USE OF HIGH DEGREES OF SUPERHEAT.

Dr. Wilhelm Schmidt—Railroad Age Gazette.

IN a series of three articles in the *Railroad Age Gazette* for July 17, 24 and 31, Dr. Wilhelm Schmidt discusses in a very simple and interesting manner the economies and advantages of the use of superheated steam in locomotives and the rules governing the design of an efficient and economical superheater. It may be noted that Dr. Schmidt was practically the pioneer in this field, and that a great many of the more important developments since a high degree of superheat was first tried in 1892 have been the result of his investigations. Below is given an outline of the more important points dealt with in his paper.

"Saturated steam of a given pressure has a certain known temperature. If heat be added to the steam while it is still in contact with water (for instance, in the boiler), more water will be evaporated, and the quantity of steam will be thus increased, but the saturation temperature remains the same as long as the pressure is kept constant. On the other hand, if heat be taken from it by cooling or by the performance of useful work during expansion, a part of the steam is condensed, and this part loses its capacity as a working fluid. This is the chief source of the losses due to cylinder condensation.

"If, however, heat be added to the steam when it is no longer in contact with water (*i. e.*, in the superheater), its temperature will be raised above that due to its pressure; in other words, it will be superheated. Such steam may be cooled in the cylinder by the same amount that it has been superheated in the boiler, without condensation taking place. It is, therefore, only necessary to superheat the steam sufficiently high, and all losses by condensation in the cylinder will be avoided. The volume per pound of steam at the given pressure increases with the temperature in a practically proportional ratio. The higher the degree of superheat, the more the steam adopts the properties of a proper gas, especially as regards low conductivity of heat.

"The volume in cubic feet of 1 pound of superheated steam is always greater than that of saturated steam of the same pressure. The higher the temperature to which steam is superheated, the larger is the volume of the steam which can be produced from each pound of water." In an ideal engine the water economy due to this increase in volume would be about 21 per cent., using steam at 170 pounds pressure superheated to 650 degrees F. Losses of heat in the cylinder, however, reduce the saving in practice to about 10 per cent. . . . .

"In the saturated steam locomotive the weight of the steam calculated from the indicator diagram is from 30 to 50 per cent. less than the weight of steam actually passed into the cylinders. The missing quantity is caused by losses due to cooling and leaking in the steam chests and cylinders." In ordinary saturated steam locomotives, condensation losses amount to over 30 per cent. Leakage losses in modern engines are not so considerable, rarely amounting to more than 10 per cent. of the losses due to cooling, and they are not increased, but rather decreased, by superheating. The condensation losses are entirely avoided by superheating, and the total water economy obtained by superheating steam at 170 pounds pressure to 650 degrees F. will be approximately 40 per cent., including the saving mentioned above as due to the increased volume.

In actual practice the water economy varies betwen 25 and 50 per cent. "This great variation in steam economy has its reasons in the different services and the varying cut-offs and speeds at which the engines are worked; on long continuous runs, where high degrees of superheat

can be steadily maintained, the best results are secured. The more the superheater locomotive is forced, the higher is the degree of superheat obtained and the more economically the engine works. This is one of the principal differences between the superheated steam and the saturated steam locomotive; the more the latter is pressed, the wetter the steam becomes, and the greater, consequently, is the quantity of water carried over into the cylinders and the less economically the engine works."

"The economy in coal is generally smaller than the water economy, because a certain coal expenditure is required to superheat the steam, or, to state the case differently, the calorific value of superheated steam is higher than that of saturated steam. . . . . The generation of 1 pound of superheated steam at 650 degrees F. consumes 12.2 per cent. more coal than the generation of 1 pound of dry saturated steam at the same pressure." If it is assumed that 5 per cent. of water is suspended in the steam, the superheating to 650 degrees requires 16.3 per cent. of the total heat required for the generation of 1 pound of wet steam. It was shown above that 60 pounds of steam superheated to 650 degrees F. will do the work of 100 pounds of saturated steam, but since the coal required to produce this degree of superheat is 16 per cent. more than that required to produce wet steam, the actual coal consumption in the case of superheated steam will be 70 per cent. of that required for saturated steam; the coal economy will therefore amount to only 30 per cent. "In practice such coal economy is not generally obtained, owing to the losses that occur during stoppages and while drifting, which are the same for both types of engines, and also on account of the varying demands made on the boiler and superheater, as these conditions influence the degree of superheat. But as a safe figure, obtained in comparative service of simple locomotives with and without the Schmidt superheater, 25 per cent. coal economy can be relied on as an average."

This saving in coal increases the boiler capacity 33 per cent.; in other words, for equal quantities of coal consumed in each engine, the superheater locomotive produces 33 per cent. more indicated horse power than the saturated steam locomotive. At the ordinary speeds of express trains only about 60 per cent. of the power of the locomotive is transmitted to the draw-bar; hence an increase of 33 per cent. in indicated horse power may represent at high speeds a gain in draw-bar horse power of 50 per cent. or more. "Superheating thus forms an efficient means for meeting in a very economical way the steadily increasing demands for more powerful locomotives, without having recourse to abnormally heavy and complicated engines. The application to new or existing locomotives of an efficient superheater, capable of producing and maintaining a high degree of superheat, is tantamount not merely to a considerable increase in boiler capacity, but also to a substantial augmentation in the haulage capacity of the engines."

The low thermal conductivity of superheated steam, a property of so much value in reducing condensation after the steam has reached the cylinders, is a great disadvantage in the production of superheat, as it impedes the free transmission of heat from the waste gases to the steam. In superheater design the great desiderata are to facilitate the transference of heat and to secure an efficient use of waste gases. The steam must be divided into as many streams as possible and it must be subjected to repeated reversals to secure thorough mixing of the moist and superheated particles. The gases must be kept in close contact with the superheater tubes and they must have a very high temperature (about 1,500 degrees F.). Ordinary waste gases can produce no material degree of superheat.

Greater efficiency is secured when the steam travels at a high velocity and this must be taken into account in superheater design. Further, it is essential to provide for the protection of the superheater parts against overheating, especially when the engine is standing or floating. Suitable dampers must be arranged for the purpose of shutting off

the flow of the gases to the superheater under these conditions.

The firebox type of superheater is the most efficient, on account of the high temperature of the heating gases acting upon it. It is impracticable, however, because of the difficulty of providing protection for the apparatus against the high temperature. The boiler-barrel superheater is small in weight and simple but it has shown very serious defects in practice. Smoke-box superheaters, relying entirely on the heat of the waste gases, are practically useless. Special types of smoke-box superheaters employing double tubes have proved very efficient in practice, but on account of their high cost of construction and maintenance, they have been superseded by the smoke-tube apparatus. In this type, the superheating surface is disposed within enlarged smoke-tubes in the boiler. The superheating tubes are usually U-bent return tubes and four are usually arranged in each of the enlarged smoke-tubes. The smoke-tube superheater using circular return tubes is at present the most efficient and practicable superheater for locomotives. By the use of a properly proportioned smoke-tube superheater, the steaming capacity and efficiency of the boiler are materially increased, the increase in efficiency amounting in some cases to 65 per cent.

"The principal advantages of the compound arrangement in saturated steam locomotives lie in the fact that it allows the use of higher boiler pressures than in simple engines, and that it reduces the losses due to condensation in the cylinders. Both advantages are the less pronounced the higher the speed of the engine, and they practically disappear for very high speeds and early cut-offs.

"Superheated steam can be applied to compound locomotives in three different ways: by 'initially' superheating the high-pressure steam; by the use of a 'two-stage' superheater; or by the use of an 'intermediate' superheater. The first is the most advantageous form. Approximately 50 degrees F. less superheat than that required in the case of a simple engine is sufficient to avoid all losses by condensation in the compound locomotive. Compared with the highly superheated steam simple locomotive, a small saving in coal, and a somewhat increased boiler capacity can be maintained in the compound locomotive.

"It is still an open question, however, and it depends very largely on the service to be done, whether the above-mentioned advantages of superheated steam compound locomotives are not more than counterbalanced by the practical difficulties inherent to the compound working, especially as regards high boiler pressures and lack of adaptability of the engine. In the author's opinion, the express engine of the future will be of the four-cylinder simple type, using highly superheated steam, and working with a moderate boiler pressure."

THE VENTILATION OF THE NEW YORK SUBWAY.

A PLAN FOR SECURING PISTON VENTILATION BY THE CONSTRUCTION OF A CENTRE WALL.

Bion J. Arnold—Report to the Public Service Commission.

AT the time of its construction, the New York subway was, in regard to magnitude of traffic, the largest work of its kind ever attempted, and, as is to be expected in all pioneer work, the importance of many problems was inadequately estimated by the designing engineers. One of the most important of these was that of ventilation. In the original design adequate provision was made to secure hygienic conditions in the subway, but not for taking care of the heating effect of the enormous train service. Several attempts have been made since the opening to improve conditions, but all have proved inadequate to the requirements. A suggestion is now made in a report by Mr. Bion J. Arnold to the Public Service Commission that a solution may lie in securing piston ventilation by building a wall between the express tracks. We give be-

low the part of Mr. Arnold's report in which this proposal is discussed.

Except at very infrequent periods, the temperature of the subway air is at all times higher than that of the street air, a condition of advantage in the winter, but of decided inconvenience in the summer. Although the air carries a large amount of dust, it is practically as pure as the street air, and, in fact, carries fewer bacteria than the latter. The oily odors, while annoying, are not harmful, and the relative humidity is lower than that of the street air. The present arrangements for ventilation, installed in 1906, consist of grated openings at stations, 25 exhaust fans in conjunction with 14 ventilating chambers with automatic louvres, 17 roof ventilating openings with automatic louvres between Ninety-sixth Street and Fifty-ninth Street, and an experimental air-cooling plant at the Brooklyn Bridge station. It was estimated that these extra openings, louvres and fans would cause a change of air once every 10 minutes in the section below Fifty-ninth Street, and once every 33 minutes above. They have caused some improvement, but their effect in cooling the subway air has been much less than was expected. During the summer, only about one-fifth of the heat, produced in part by radiation from the passengers, but principally from electrical losses, friction, etc., in the motors and cars, is carried by the air through the openings to the street. The remainder tends to escape through the sides and bottom of the subway, but only in a few short sections are the walls capable of carrying off large quantities of heat.

Refrigeration, either by the rapid expansion of compressed air or by the evaporation of volatile liquids, would be an effective means of cooling the air, but the cost of the installations necessary to produce a cooling effect of more than a few degrees would be prohibitive. There are objectionable features also in plans for cooling the air by water, either by forcing the air by fans over pipes in which cool water is circulated by pumps, or by drawing the air through fine sprays of cool water.

"The automatic louvres connected with the 14 ventilating chambers bordering the subway between Fifty-ninth Street and City Hall are so constructed as to prevent any street air passing through them into the subway. They open upon sufficient air pressure being created by an approaching train and then only to allow the heated air to be discharged. This plan of operation was intended to draw the cooler street air into the subway at stations and to discharge the heated air from the subway through these louvred openings between stations. On account, however, of the conflicting air currents set up by the opposite train movements and the slow speed of the trains in approaching some of these louvres, there often results an absence of the necessary air pressure to open them. As a consequence these louvres are open only about 25 per cent. of the time. Mechanical devices should be arranged to keep these louvres open during the day and to allow them to operate at night so that the exhaust fans could be used to remove some of the heated air. This should be done. By this arrangement these openings would add an area for free passage of air equal to one-half the area of the present effective station openings, and would allow large quantities of the cooler street air to be drawn into the subway, thus making these openings much more effective than at present.

"The keeping of the louvres open and thereby producing 'cold spots' in the vicinity of the louvres would not noticeably change the present ventilating system, for the small quantities of air now passing through the louvres do not cause any noticeable influx of air at the stations to take the place of this discharged air. If, on the other hand, these louvres were blocked open there would be an appreciable effect of cooler air upon the passengers when passing these free openings, thus relieving the depressing effect due to the constant temperature now existing between the stations. Every effort should be made to get as many openings as practicable from the subway to the street surface wherever such openings can be protected from street traffic.

"The more often fresh, cool air is drawn into the subway and heated air discharged, the lower will be the temperature therein. The subway air averages about 6 degrees hotter during the summer than the street air, although there are some times during the summer when the subway is from 12 to 15 degrees hotter than the outside air. While there is a difference in temperature between the street air and the subway air, the openings along the route of the subway are practically on the same level as the roof of the subway, so that the quantity of heated air rising and replaced by the cooler entering air (an action similar to the ordinary fireplace ventilation in dwellings) is practically negligible. This air can be made to travel in the same direction as the trains by constructing a division wall between the tracks upon which trains travel in opposite directions. This division wall would enable each train to push out a large quantity of air as it approaches a free opening and to draw in considerable air as it passes the opening, thus producing what might be termed 'piston ventilation.' This system operating in the subway would make a change of air therein at least six times per hour during the day, instead of two times per hour as at present, thus noticeably increasing the present ventilation, as well as relieving, to a considerable extent, the heated conditions prevalent during the summer, making the subway more responsive to the outdoor temperature changes and decreasing the power necessary to overcome the air pressure which now exists against the front of the trains, due to the counter currents caused by the rapidly moving trains in opposite directions.

"Moreover, the present system of ventilation would be made much more effective. The openings at the stations which now have a slow, uncertain and changeable velocity of air passing through them, would pass greater quantities of air in long extended draughts, making the passengers feel the air movements. The 25 exhaust fans, which now can just about take care of the heat given off by the trains during the night operation, could remove some of the stored heat for which they are well adapted All of these increased operations would combine to draw cool air into the subway in quantities at least three times as great as at present.

"The continuous air movements which are obtained by trains running in tubes or where they travel in the same direction in one space can be shown to exist in the Brooklyn tubes of the subway under the East River; in the section between the Grand Central station and Thirty-third Street station; in the Hudson tunnel and sections under Sixth Avenue and in the London tubes. All tubes now being installed under the rivers to Manhattan Island will have this piston ventilation.

"To decrease the heated conditions of the subway and increase its ventilation, the following recommendations are made:

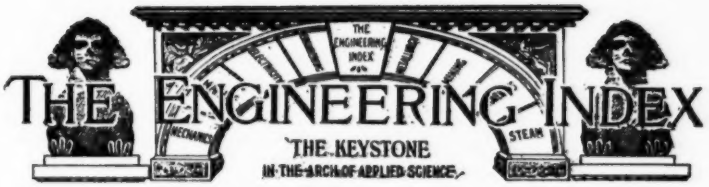
(1) Block the present louvres open during the day and allow them to operate at night when the fans are being run.

(2) Construct as many protected openings as practicable between the subway and the street.

(3) At the Fourteenth Street and Grand Central stations install large disk fans located in such a way as to draw air from the street through the kiosks and force this air in large volumes down upon and among the persons waiting for trains upon the platforms.

(4) Construct a solid continuous division wall between the downtown and uptown express tracks extending from the north end of Ninety-sixth Street station to and including Brooklyn Bridge station.

"For the purpose of demonstrating the feasibility of such a wall, it is suggested that the section extending south from the center wall now at Thirty-third Street station be constructed first far enough south as to include the Fourteenth Street station. At stations the upper half of the wall to have vertically sliding counterweighted windows between columns."



The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Blackwell's Island.

Anchorages for Blackwell's Island Bridge Cantilever Spans. Illustrated detailed description. 2500 w. Eng Rec—Aug. 8, 1908. No. 94230.

Draw Bridges.

Swing Bridge at Littlehampton. Drawings and description of structure over the river Arun. 700 w. Engr, Lond—Aug. 14, 1908. No. 94481 A.

Manhattan.

The Suspended Falsework for the Manhattan Bridge. Illustrated description of the method of constructing the cables and the temporary construction footbridges. 2200 w. Eng Rec—Aug. 8, 1908. No. 94227.

Erecting the Construction Footways of the Manhattan Bridge. Illustrated description of the method of erecting these footways for the stringing of the cables. 800 w. Sci Am—Aug. 1, 1908. No. 94119.

Piers.

Cost of Piers of the Chattahoochee River Viaduct. John W. Ash. Describes the work and gives costs. Ills. 2000 w. Eng Rec—Aug. 29, 1908. No. 94689.

We supply copies of these articles. See page 159.

The Sinking of the Piers for the Grand Trunk Pacific Bridge at Fort William, Ontario, Canada. H. L. Wiley. Outlines the construction methods used in sinking the piers for the bridge crossing the Kaministiquia River. Ills. 2000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94670 E.

Quebec.

The Design of the Quebec Bridge: Report of C. C. Schneider, with Theodore Cooper's Specifications. Gives the specifications to govern the design and execution, and an abstract of C. C. Schneider's report. Also editorial. 5800 w. Eng News—Aug. 6, 1908. No. 94224.

Reinforced Concrete.

Three-Hinged Reinforced Concrete Bridge at Santa Cruz, California. James K. James. Illustrates and describes interesting features of design, and methods of construction. 1500 w. Cal Jour of Tech—Aug., 1908. No. 94605.

Reinforced-Concrete Bridges for Track Elevation on the Illinois Central R. R.: Failure Tests of Very Large Concrete Slabs. Illustrates and describes bridges of the slab or beam construction, describing the tests of these large reinforced-concrete beams. 4500 w. Eng News—Aug. 6, 1908. No. 94223.

See also Viaducts, under BRIDGES; and Reinforced Concrete, under CONSTRUCTION.

Steel

The McKees Rocks Bridge. Details of floor construction and guard rails for this unusually heavy structure are illustrated and described. 900 w. Eng Rec—Aug. 29, 1908. No. 94695.

Walney Island Bridge. Drawings and detailed description of this new bridge connecting Walney Island and Barrow-in-Furness. 1500 w. Engr, Lond—July 24, 1908. Serial, 1st part. No. 94166 A.

Atchafalaya River Bridge of the Southern Pacific. Describes a railroad bridge of interest because of its size and the unusual conditions of its construction. Ills. 1200 w. R R Age Gaz—Aug. 7, 1908. No. 94215.

The Passy Bridge Over the Seine for the Metropolitan of Paris (Viaduc de Passy, sur la Seine pour le Chemin de Fer Métropolitain de Paris). L. Biette. Illustrated description of this arch bridge. Serial, 1st part. 3500 w. Génie Civil—July 25, 1908. No. 94534 D.

Viaducts.

Street Viaducts Over the New York Central Terminal Yards at New York. Illustrates and describes the plate girder construction used. 1800 w. Eng Rec—Aug. 1, 1908. No. 94065.

Construction of the Substructure for the Mulberry Street Viaduct, Harrisburg, Pa. Illustrated detailed description of the methods of construction for this reinforced-concrete viaduct. 2500 w. Eng Rec—Aug. 29, 1908. No. 94686.

The Mulberry Street Viaduct, Harrisburg, Pa. A reinforced-concrete structure, to replace a steel bridge, is illustrated and described in detail, and the methods of construction explained. 2500 w. Eng Rec—Aug. 15, 1908. No. 94343.

CONSTRUCTION.

Beams.

See Reinforced Concrete, under CONSTRUCTION.

Bins.

Method of Building a Concrete Coal Bin, etc. Ernest McCullough. Gives formulæ for calculating the pressure of coal, and also compression and tension stresses, etc. 2200 w. Min Wld—Aug. 1, 1908. No. 94096.

Reinforced Concrete Bins for Fine Materials (Silos di Cemento Armato per Materiali in Polvere). An illustrated, mathematical discussion of their design. 3500 w. Il Cemento—June, 1908. No. 94539 D.

See also Tanks, under WATER SUPPLY.

Caissons.

Pneumatic Caissons. T. Kennard Thomson. Illustrated detailed description of caisson work, especially in New York City and vicinity, with reference also to work in other places. 6000 w. R R Age Gaz—Aug. 7, 1908. Serial, 1st part. No. 94218.

Campanile.

The Rebuilding of the Venice Campanile. A detailed account of the reconstruction. The present number deals with the foundations. 2200 w. Builder—Aug. 15, 1908. Serial, 1st part. No. 94411 A.

The Reconstruction of the Campanile of St. Mark, in Venice (Reconstruction du Campanile de Saint-Marc, à Venise). P. Raulin. A review of plans and the work already accomplished. Ills. 4000 w. Génie Civil—July 4, 1908. No. 94529 D.

Coal Pockets.

A Large Reinforced-Concrete Coal Pocket at Charlestown, Mass. George P. Carver. Illustrations, with descriptions of methods of construction. 1500 w. Eng News—Aug. 27, 1908. No. 94637.

Concrete.

See Manholes, under WATER SUPPLY.

Concrete Blocks.

Hollow Tile and Concrete Block Construction. Warren H. Miller. Suggestions for building with this material. 2500 w. Eng Rec—Aug. 22, 1908. No. 94493.

We supply copies of these articles. See page 159.

The Development of the Cement and Artificial Stone Industry (Lo Sviluppo dell' Industria dei Lavori in Cemento e delle Pietre artificiali). Illustrates and describes machines and methods for producing cement blocks. 2200 w. Il Cemento—June, 1908. No. 94540 D.

See also Stacks, under CONSTRUCTION.

Excavation.

The Cost of Digging Wet Holes, with Some Comments on Furnishing Special Clothing for Workmen. 1200 w. Engng-Con—July 29, 1908. No. 94111.

A New Method of Wet Excavating. C. M. Ripley. Brief illustrated description of methods used at Gary, Ind., in overcoming the difficulties of quicksand. 1200 w. Ir Age—Aug. 6, 1908. No. 94181.

Methods and Cost of Earth and Rock Excavation with a Steam Shovel and the Cost of Repairing a Wrecked Steam Shovel. Describes the work and methods, giving itemized costs. 3000 w. Engng-Con—Aug. 5, 1908. No. 94204.

Floors.

The Design of Reinforced-Concrete Floors (Metodo di Calcolo per Impalcature in Ferro-Cemento). Mathematical. Ills. 2500 w. Ing Ferro—July 31, 1908. No. 94546 D.

Foundations.

Foundations, with Special Reference to Modern Methods and Plant. Percival M. Fraser. Considers the principles involved, best methods in special cases, etc. 10000 w. Jour Inst of San Engrs—April, 1908. No. 94312 C.

Gymnasium.

The Syracuse University Gymnasium. Illustrated description of a steel-skeleton frame, with stone, brick, and terra-cotta walls, and with reinforced-concrete and tile floor construction. 2000 w. Eng Rec—Aug. 22, 1908. No. 94492.

Reinforced Concrete.

Some Problems in Reinforced Concrete Engineering. H. Alexis d'O. Saurbrey. A study of stresses in beams with straight reinforcement, and beams with bent-up bars. Ills. 5500 w. Eng Rec—Aug. 22, 1908. No. 94490.

Economy in Ferro-Concrete Design. Oscar Faber. Considers the question of economy in design, giving tabulated statements of strength and cost. 3500 w. Engng—Aug. 7, 1908. Serial, 1st part. No. 94370 A.

Formulæ for Reinforced Concrete in Flexure in the Light of Experimental Data. William Fry Scott. Read before the Am. Soc. for Test. Materials. Discusses whether a plane section before bending remains a plane section after bending. 1800 w. Can Engr—Aug. 7, 1908. No. 94240.

The Design of Rectangular Concrete Slabs with Crossed Reinforcement (Ein Beitrag zur statischen Berechnung von mit sich kreuzenden Eiseneinlagen versehenen rechteckigen Betonplatten). M. Manitius. Mathematical. Ills. 3000 w. Beton u Eisen—July 27, 1908. No. 94588 F.

The New Plant of the Wheatena Co., Rahway, N. J. Illustrated description of a reinforced-concrete structure having features of interest. 3000 w. Eng Rec—Aug. 29, 1908. No. 94694.

The Color Plant of the G. Siegle Company. Illustrated description of the reinforced-concrete buildings erected at Rosebank, Staten Island, N. Y., and their equipment. 2000 w. Eng Rec—Aug. 1, 1908. No. 94066.

Canal Roof with Market Hall and Highway Bridges in Mülhausen (Kanalüberdeckung mit Markthalle und Strassenbrücke in Mülhausen i. E.). W. Custer. Illustrated description of extensive reinforced-concrete construction. Serial, 1st part. 1800 w. Schweiz Bau—July 4, 1908. No. 94565 D.

See also Bins, Coal Pockets, and Floors, under CONSTRUCTION; Testing Materals, under MEASUREMENT; Aqueducts, and Pipe Making, under WATER SUPPLY; Docks, under WATERWAYS AND HARBORS; and Car Barns, under STREET AND ELECTRIC RAILWAYS.

Stacks.

Power Plant Chimney with Concealed Exhaust Pipe. Illustrates and describes an unusual construction at the new Union Terminal Station at Washington, D. C. 1000 w. Eng Rec—Aug. 29, 1908. No. 94699.

A Chimney of Concrete Blocks Built Without the Use of Scaffolding. Illustrated description of a novel construction invented by M. Dumas, of Brussels. 600 w. Eng News—Aug. 20, 1908. No. 94428.

Steel Buildings.

A Steel Frame Hay Barn. A structure of unusual interest at Dryden, N. Y., is illustrated and described. 1600 w. Eng Rec—Aug. 15, 1908. No. 94346.

Conservatory Buildings of Steel Construction in Garfield Park, Chicago. Interesting feaures of structural steel work are illustrated and described. 1200 w. Eng News—Aug. 27, 1908. No. 94635.

See also Gymnasium, under CONSTRUCTION.

Theatres.

Optics and Acoustics in Theatre Design (L'Optique et l'Acoustique au Théatre). Alfred Lacour. Notes on auditorium design and lighting. Ills. 10000

We supply copies of these articles. See page 159.

w. Bul Soc d'Encour—July, 1908. No. 94516 G.

Tunnels.

The Lötschberg Tunnel. Editorial on the work of constructing this tunnel under the Bernese Alps. 1000 w. Engng—July 31, 1908. No. 94272 A.

Construction of the Lötschberg Railway (Der Bau der Lötschbergbahn). A. Zollinger. Describes the tunneling operations. 2200 w. Schweiz Bau—July 25, 1908. No. 94567 D.

MATERIALS OF CONSTRUCTION.

Brick.

Silica-Lime Brick (El Ladrillo Silico-Calcáreo). Description of a large plant in Brazil and notes on the properties of the product. Ills. 8500 w. Ingenieria—July 15, 1908. No. 94547 D.

Cement.

Portland Cement Mortars and Their Constituent Materials. Richard L. Humphrey and William Jordan, Jr. A review by Henry S. Spackman of Bul. 331, U. S. Geol. Survey, which gives results of tests made of different cements and sands, screenings, etc. 2500 w. Cement Age—, Aug., 1908. No. 94384.

Concrete.

Tests on Bonding New Concrete to Old. Raymond B. Perry. A report of experimental investigations and the results. 1200 w. Eng News—Aug. 13, 1908. No. 94319.

Cement—Its Use and Abuse. Robert W. Lesley. Discusses the use of Portland cement concrete as a structural and decorative material. 3000 w. Jour Fr Inst—Aug., 1908. No. 94295 D.

Chemical Tests on the Alteration of Concrete in Railway Overbridges (Chemische Untersuchungen über die Veränderung des Betons der Monier-Ueberfahrten in den Stationen Mödling und Guntramsdorf der k. k. priv. Südbahn-Gesellschaft). Josef Klaudy. Investigations to determine the effects of locomotive gases on concrete construction. Serial, 1st part. 5000 w. Zeitschr d Oest Ing u Arch Ver—July 24, 1908. No. 94585 D.

See also Pavements, under MUNICIPAL.

Masonry.

The Effect of Temperature Changes on Masonry. Discussion of paper by Charles S. Gowen. Ills. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94672 E.

Mortars.

Hydrated Lime and Cement Mortars. E. W. Lazell. Read before the Am. Soc. for Testing Materials. A report of experiments made to learn the amount of hydrated lime that could be advantageously added to cement mortars. 1200 w. Eng Rec—Aug. 29, 1908. No. 94698.

Reinforced Concrete.

The Resistance to Slipping of Reinforcement (Der Gleitwiderstand bei den Verbundkörpern). C. Doucas. Mathematical discussion and report of tests. Ills. 7000 w. Beton u Eisen—July 2, 1908. No. 94586 F.

A Test of Large Reinforced Concrete Beams. Arthur N. Talbot. Describes the testing apparatus and method of making test of very large beams, representing actual conditions of construction, and gives a comparison of the efficacy of two methods of reinforcement. Ills. 3500 w. Eng Rec—Aug. 1, 1908. No. 94069.

Steel Inspection.

The Inspection of Structural Steel. P. S. Hildreth. Remarks on the necessity and value of this work, discussing the details of good inspection of this material. 3500 w. Cal Jour of Tech—Aug., 1908. No. 94604.

Timber Preservation.

Wood Preservation. W. F. Sherfesee. Abstract from Circ. of U. S. Dept. of Agri. Explains the meaning of decay and how it may be checked. 5000 w. Sci Am Sup—Aug. 1, 1908. No. 94117.

The Preservative Treatment of Loblolly Pine Cross-Arms. W. F. Sherfesee. An illustrated study of the seasoning, treating, grading, etc., with record of tests. 8000 w. U S Dept of Agri, Circ 151—July 31, 1908. No. 94619 N.

MEASUREMENT.

Hydrographic Surveying.

Soundings in Niagara Gorge and Under the Falls. Dr. J. W. Spencer. Describes the methods used, and the facts determined. 1600 w. Sci Am—Aug. 1, 1908. No. 94120.

Standardizing.

Testing Steel Tapes at the National Bureau of Standards. Herbert T. Wade. Describes the methods of testing used by the Bureau of Standards. 2200 w. Eng News—Aug. 13, 1908. No. 94323.

Surveying.

See Geological Surveys, under MINING AND METALLURGY, MINING; and Surveying, under RAILWAY ENGINEERING, NEW PROJECTS.

Surveying Tapes.

See Standardizing, under MEASUREMENT.

Testing Materials.

A Method of Detecting the Bending of Columns: Including a Description of the Sphingometer. C. A. M. Smith. Illustrates and describes this instrument and its use. 3000 w. Inst of Mech Engrs—July 28, 1908. No. 94263 N.

Standards and Specifications for the Testing and Acceptance of Iron (Norme

e Condizioni per le Prove e l'Accettazione dei Materiali ferrosi). Refers particularly to the testing of steel for concrete reinforcement. Ills. 3500 w. Il Cemento—June, 1908. No. 94541 D.

MUNICIPAL.

Bridlington.

Some Municipal Works Carried Out by the Bridlington Corporation During the Past Ten Years. Ernest R. Matthews. Read before the San. Inspectors' Assn. Describes sewage disposal, electricity works, street widenings and other improvements. Ills. 5500 w. Surveyor—Aug. 14, 1908. No. 94454 A.

Burgess Hill.

Burgess Hill and Its Local Government. E. Brown. An account of the highways, sewage disposal, water supply, etc. 3000 w. Surveyor—Aug. 14, 1908. No. 94455 A.

City Planning.

I. Town Planning. William Harpur. II. Town and Street Planning. Raymond Unwin. III. Street and City Planning. Henry M. Whitley. Three papers read before the Roy. San. Inst. Congress, and discussed together. 6500 w. Surveyor—Aug. 14, 1908. No. 94453 A.

Garbage Disposal.

Recent Practice in Garbage Disposal (Neuere Erfahrungen auf dem Gebiete der Müllbeseitigung). Dr. Thiesing. Discusses the importance of the problem and outlines methods employed in Charlottenburg, Germany. Ills. 8800 w. Gesundheits-Ing—July 25, 1908. No. 94580 D.

See also Fuels, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Pavements.

Concrete Paving for Streets. Considers the use of concrete as a paving material, giving experience in various cities. Ills. 4500 w. Eng News—Aug. 20, 1908. No. 94425.

Modern Street Work in the West. Walter C. Howe. Briefly considers macadam, asphalt, wood-block, bitumen, vitrified brick, and asphalt-macadam pavements as experienced in the city of Oakland, Cal. 1700 w. Cal Jour of Tech—Aug., 1908. No. 94606.

Roads.

The New Marine Drive, Scarborough. Illustrations and information in regard to this recently opened drive in England. 1200 w. Engr, Lond—Aug. 7, 1908. No. 94375 A.

The Maintenance of Macadam and Other Roads. Informal discussion at annual convention. Ills. 9000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94674 E.

The Construction of Macadam Roads. Austin B. Fletcher. Abstract of Bul. U. S. Dept. of Agri. How rural highways may be improved. Ills. 4000 w. Sci Am Sup—Aug. 1, 1908. Serial, 1st part. No. 94116.

Sewage Disposal.

State Control of Sewage Disposal Works. Editorial on the progress made in establishing State control in Europe and America, the difficulties, etc. 1400 w. Eng News—Aug. 13, 1908. No. 94324.

Some Minor Points in Sewage Disposal and the Hampton Doctrine. R. Aglio Dibdin. States and answers doubts expressed in regard to systems of sewage disposal. 2000 w. Surveyor—July 24, 1908. No. 94144 A.

Sewage Disposal Without Sewers at Haworth, N. J. Illustrated detailed description of individual sewage disposal plants requiring no sewer system. The Ashley system. 3000 w. Met Work—Aug. 22, 1908. No. 94431.

The Broad Irrigation Sewage Farm at Fresno, California. Illustrated description of the sewage disposal system for a population of 30,000. 1500 w. Eng Rec—Aug. 22, 1908. No. 94488.

Investigations of the Distribution of Sewage Upon Trickling Filters. Stephen DeM. Gage. A report of investigations made at the Lawrence Experiment Station of the Mass. Board of Health. Ills. 9000 w. Eng News—Aug. 20, 1908. No. 94427.

See also Bridlington and Burgess Hill, under MUNICIPAL; and Pumping Plants, under MECHANICAL ENGINEERING, HYDRAULIC MACHINERY.

Sewers.

New Sewerage System of Washington. Plan and description. 3500 w. Eng Rec—Aug. 1, 1908. No. 94068.

Cost of a Large Brick Sewer at Gary, Ind. E. M. Schaflow. Gives details of cost of building a large sewer in a water-soaked sandy soil. 1500 w. Eng Rec—Aug. 29, 1908. No. 94693.

The Pumping Station Conduits and Outfall Sewer of the Washington Sewerage System. Illustrated detailed description of the features named and their construction. 4000 w. Eng Rec—Aug. 29, 1908. No. 94691.

Replacing a Sewer Outlet by a Wood-Stave Sewer, New York City. Describes work at West 42nd St., New York City, explaining conditions. Ills. 900 w. Eng Rec—Aug. 15, 1908. No. 94345.

Sewer Trenches.

Method of Excavating a Sewer Trench in Water Soaked Sand, Using the Bleeding Method of Unwatering the Soil, with Some Estimates of Costs. Illustrated description of the successful application of bleeding the sand by means of well points.

We supply copies of these articles. See page 159.

2500 w. Engng-Con—Aug. 5, 1908. No. 94205.

WATER SUPPLY.

Aqueducts.

Some Methods Employed in Constructing the 7½-Mile Reinforced-Concrete Aqueduct for the Water Supply of Salt Lake City. Illustrates and describes the construction of one of the largest reinforced-concrete aqueducts ever built. 1200 w. Engng-Con—Aug. 5, 1908. No. 94203.

Basingstoke, Eng.

The Water Supply of Basingstoke. F. R. Phipps. Reviews the history of the public water supply. Discussion. Ills. 8000 w. Surveyor—July 31, 1908. No. 94249 A.

California.

Rain and Run-Off Near San Francisco, California. Discussion of paper by C. E. Grunsky. 5000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94673 E.

Conduits.

See Manholes, under WATER SUPPLY.

Dams.

The Damming of the Murrumbidgee River, Australia. C. O. Burge. A description of this irrigation scheme. 2200 w. Eng Rec—Aug. 8, 1908. No. 94232.

A Formula for Calculating Flashboards for Dams. Richard Muller. Gives an analysis of the bending conditions of pins from actual tests, and develops a formula for calculating the maximum head of water over the crest of the dam. 700 w. Eng Rec—Aug. 22, 1908. No. 94489.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Evaporation.

Evaporation from the Salton Sea. C. E. Grunsky. Describes the conditions and gives information concerning the evaporation records made, and the special studies about to be made in the Salton Basin. 4000 w. Eng News—Aug. 13, 1908. No. 94317.

Filtration.

The Water Softening and Filtration Plant at McKeesport, Pa. Illustrated description of a 10,000,000-gal. plant for the treatment of river water. 4500 w. Eng Rec—Aug. 1, 1908. No. 94064.

The Bamford Filters of the Derwent Valley Water Board. Andrew Williamson. Illustrated description of this scheme which will supply 36-million gallons per day. 3500 w. Engng—July 24, 1908. No 94158 A.

Ground Waters.

The Underground Water Supply of Indiana. F. G. Clapp. A study of this district, giving a classification of underground supplies. 5000 w. Eng Rec—Aug. 8, 1908. No. 94228.

Indiana.

See Ground Waters, under WATER SUPPLY.

Irrigation.

Irrigation. Informal discussion on irrigation problems at the annual convention. 6500 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94675 E.

Irrigation of the Yuma Valley. Day Allen Willey. Illustrates and describes the construction of the extensive mileage of levees in connection with the Yuma project. 1500 w. Sci Am—Aug. 1, 1908. No. 94118.

Italy.

The New Apulia Water Supply (Die neue apulische Wasserleitung). Herr Beraneck. Description of the new water supply for the three provinces of Lecce, Bari, and Foggia in Southern Italy, the conduits, etc. Ills. Serial, 1st part. 1600 w. Zeitschr d Oest Ing u Arch Ver—July 3, 1908. No. 94583 D.

Manholes.

Methods and Labor Cost of Constructing Over 200 Concrete Vaults for Underground Conduit. Records of work done in a middle Western State, through suburban towns and country. Ills. 500 w. Engng-Con—Aug. 12, 1908. No. 94339.

Pipe Flow.

The Flow of Water in Spiral Riveted and Other Pipes. E. W. Schoder and H. A. Gehring. Gives results of recent studies. 1000 w. Eng Rec—Aug. 29, 1908. No. 94692.

Pipe Laying.

Lowering a 24-in. Water Pipe in Street Grade Changes at Detroit, Mich. Illustrates and describes methods of work. 800 w. Eng News—Aug. 13, 1908. No. 94320.

Pipe Lines.

A 160-Mile Pipe-Line Water Distribution System on the El Paso & Southwestern Ry. A system in New Mexico including 160 miles of wood-pipe, a storage reservoir, and pumping stations, is illustrated and described. 5000 w. Eng News—Aug. 27, 1908. No. 94636.

Pipe Making.

Ferro-Concrete Pipe-Weaving Machine. An account of a steel and concrete weaving machine for making poles, pipes, piles, etc. A Swiss invention. 900 w. Eng—July 31, 1908. No. 94273 A.

Pollution.

Experiences with Salt Water and Oil in a Public Water Supply. Quince Walling. Read before the Indiana Conference. An account of a supply at Muncie, Ind., ruined by the discovery of oil in the region, and the way out of the difficulty. 2000 w. Munic Engng—Aug., 1908. No. 94284 C.

We supply copies of these articles. See page 159.

Purification.

Ozone Water-Purification System. G. M. Dyott. Illustrated description. 1000 w. Elec Wld—Aug. 29, 1908. No. 94634.

Rates.

Water Rates and Rentals. Charles Carroll Brown. Read before the Indiana Conference. A discussion of the principles upon which water rates and rentals should be based. 2000 w. Munic Engng—Aug., 1908. No. 94283 C.

Storage Reservoirs.

Storage Reservoirs (Die Stauweiher). Dr. P. Kresnik. A mathematical discussion of their design with reference to rainfall, run-off, etc. 3800 w. Oest Zeitschr f d Oeffent Baudienst—July 25, 1908. No. 94582 D.

Tanks.

Design of the Walls of Cylindrical Reservoirs (Berechnung der Wandungen zylindrischen Reservoire). Th. Bielakoff. Mathematical. 2200 w. Beton u Eisen—July 2, 1908. No. 94587 F.

Water Works.

History and Description of Cape Town Water-Works. R. O. Wynne-Roberts. Presented before the Assn. of Water Engrs. Ills. 5000 w. Surveyor—July 24, 1908. Serial, 1st part. No. 94143 A.

WATERWAYS AND HARBORS.

Bombay.

Port and Harbor Improvements at Bombay. Plan and description of the scheme. 2000 w. Engr, Lond—Aug. 14, 1908. No. 94478 A.

Canals.

Accident to Cornwall Canal Embankment. Illustrated account of the accident on June 23rd, on the Cornwall Canal, which runs parallel with the St. Lawrence River, causing the wreckage of a draw-span. 500 w. Engr, Lond—July 24, 1908. No. 94168 A.

See also Seepage Prevention, under WATERWAYS AND HARBORS.

Docks.

Reinforced Concrete Work in Maritime Situations. Brysson Cunningham. Gives illustrated descriptions of modern concrete constructions in dock and harbor work. 3000 w. Cassier's Mag—Aug., 1908. No. 94175 B.

Dredging.

The Operation of the Hydraulic Dredge, "General C. B. Comstock"; Galveston Harbor, Tex. Emile Low. A short description of this dredge and report of its work in Galveston harbor. 2200 w. Eng News—Aug. 20, 1908. No. 94430.

English Channel.

The Means of Communication Across the English Channel and the Question of Ferry Boats (Les Moyens de Communication à Travers le Pas-de-Calais et la Question des Ferry-boats). J. Legrand. Presents the advantages of a train ferry. Ills. 9000 w. Mem Soc Ing Civ de France—June, 1908. No. 94509 G.

English Rivers.

English Rivers: Their Uses and Control. Frank Rayner. Read before the Inst. of Munic. & Co. Engrs. A criticism of the administration of English rivers, and matters relating to their improvement. Discussion. 3500 w. Surveyor—July 24, 1908. No. 94142 A.

Harbors.

The Jetty and Port Works of Rio Grande do Sul, Brazil. From an article by E. L. Corthell. Describes the conditions and the projected improvements to cost $10,125,000. 1800 w. Eng Rec—Aug. 15, 1908. No. 94344.

See also Bombay, under WATERWAYS AND HARBORS.

Levees.

See Irrigation, under WATER SUPPLY.

Mechanical Locks.

Reconstruction of the Anderton Boat Lift. An illustrated article giving the chief points in the history of the old lift and a description of the reconstruction work. Hydraulic power has been superseded by electricity. 5500 w. Engr, Lond—July 24, 1908. No. 94164 A.

Panama Canal.

See Shops, under RAILWAY ENGINEERING, PERMANENT WAY AND BUILDINGS.

River Regulation.

The Regulation Works in Progress on the More Important Rivers of Hungary (Die an den bedeutenderen Flüssen Ungarns durchzuführenden Regulierungsarbeiten). Armin Just. Describes the works and the results expected. 11500 w. Oest Wochenschr f d Oeffent Baudienst—July 11, 1908. No. 94581 D.

Sea Walls.

Two Types of Sea Wall for Land Filling, New York City. Short description of work at North Brother Island and Riker's Island in the East River. Ills. 1500 w. Eng Rec—Aug. 22, 1908. No. 94491.

Seepage Prevention.

The Prevention of Seepage from Ditches and Canals. From a report by B. A. Etcheverry of investigations made in California. 3500 w. Eng Rec—Aug. 29, 1908. No. 94688.

U. S. Waterways.

"A Wheel in the Middle of a Wheel." Lewis M. Haupt. A discussion of the proposed systematic improvement of U. S. waterways, and the attitude of Congress toward this work. 5500 w. Jour Fr Inst—Aug., 1908. No. 94296 D.

We supply copies of these articles. See page 159.

Water Powers.

The Use and Conservation of Water-Power Resources. H. von Schon. Examines the economic aspects of water-power conservation, giving a plan for federal, state, and corporate co-operation. 4500 w. Engineering Magazine—Sept., 1908. No. 94676 B.

MISCELLANY.

Forest Survey.

Forest Survey Methods. A. H. D. Ross. States the points included, and the methods used in complete surveys. 5600 w. Can Engr—Aug. 7, 1908. No. 94241.

Natural Resources.

Conservation of Power Resources. H. St. Clair Putnam. Reviews the phases of development of power resources, discussing the use of steam, water-power, and electric power, possible economies, etc. 2500 w. Pro Am Inst of Elec Engrs—Aug., 1908. No. 94298 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Radio-Telegraphy.

A Tantalum Wave-Detector, and Its Application in Wireless Telegraphy and Telephony. L. H. Walter. Read before the Royal Soc. Describes this form of detector, and reports results obtained. 2500 w. Elect'n, Lond—Aug. 14, 1908. No. 94463 A.

Radio-Telephony.

Recent Improvements in Radio-Telephonic Methods and Apparatus. L. H. Walter. Reviews recent patents relating to wireless telephony. 2200 w. Elec Engng—Aug. 13, 1908. No. 94462 A.

Submarine Cables.

The Atlantic Cable of 1858. William Maver, Jr. A review of the early history of cable making and laying, especially discussing the cable named. 3500 w. Elec Wld—Aug. 22, 1908. No. 94419.

Telephotography.

Telephotography (La Phototélégraphie). G. Cerbeland. A review of the various systems for the electrical transmission of pictures. Ills. 5200 w. Mem Soc Ing Civ de France—June, 1908. No. 94507 G.

DISTRIBUTION.

Controllers.

A No-Segment Graphite-Resistance Controller. Illustrates and decribes a controller on the principle of the carbon microphone. 1000 w. Sci Am—Aug. 15, 1908. No. 94337.

Fire Hazard.

Insulation Resistance and Other Tests in Completed Electrical Installations. Hugh T. Wreaks. An account of tests recently made and comments on their value. 2200 w. Elec Wld—Aug. 8, 1908. No. 94211.

Fuses.

See Protective Devices, under TRANSMISSION.

DYNAMOS AND MOTORS.

A. C. Motors.

Alternating Current Commutator Motors. Dr. Rudolph Goldschmidt. Discussion of the theory of the single-phase commutator motor. 3500 w. Elect'n, Lond—July 31, 1908. Serial. 1st part. No. 94254 A.

The Shape of the Current Curves in Three-Phase Motors and the Separation of the Losses. Dr. K. Simons and K. Vollmer. Abstract trans. from *Elektrotechnische Zeit.* A study, by means of the oscillograph, of losses in 3-phase motors. 1500 w. Elect'n, Lond—July 24, 1908. No. 94153 A.

High Speed Three-Phase Motors (Drehstrommotoren für hohe Umlaufszahlen). Georg Lewinnek. Describes recent developments in horizontal and vertical motors with forced lubrication. Ills. 2000 w. Elektrotech Zeitschr—July 2, 1908. No. 94654 D.

A System of Operation for Electric Railways and Hoisting Installations Using A. C. Motor with Two Moveable Parts (Betriebssystem für Elektrische Bahnen und Förderanlagen mit Benützung eines Wechselstrommotors mit zwei beweglichen Teilen). Dr. Johann Sahulka Ills. 2500 w. Elektrotech u Maschinenbau—July 26, 1908. No. 94594 D.

Commutation.

Theory of the Commutation of D. C. Machines Without Angular Displacement (Théorie de la Commutation des Machines à Courant continu sans Décalage). R. Voisin. Ills. 2500 w. L'Elecn—July 25, 1908. No. 94524 D.

D. C. Dynamos.

Unipolar and Commutator Direct-Current Machines (Unipolarmaschinen und Kommutator-Gleichstrommaschinen). Otto Schulz. Discusses mathematically the characteristics of unipolar machines for use with steam turbines. Ills. 4000 w. Elektrotech u Maschinenbau—July 19, 1908. No. 94593 D.

Armature Reaction in D. C. Dynamos (Sur la Réaction d'Induit dans les Dynamos à Courant Continu). M. Swyngedauw. A mathematical and theoretical

paper on both longitudinal and transverse reaction. Ills. 14000 w. Bul Soc Int d'Elecns—July, 1908. No. 94511 F.

D. C. Motors.

Design for a 1-H.P. Shunt-Wound Motor. F. C. Mason. Working drawings and description. 1600 w. Elec Wld—Aug. 1, 1908. No. 94109.

D. C. Turbo-Generators.

European Practice in Direct Current Turbo-Generators. J. S. S. Cooper. Illustrates and describes some of the methods adopted by European manufacturers to produce a thoroughly satisfactory commercial machine. 3000 w. Elec Jour—Aug., 1908. No. 94291.

Induction Motors.

New Methods for the Regulation of Asynchronous Motors and Their Application for Various Purposes (Neue Methoden zur Regelung von Asynchronmotoren und ihre Anwendung für verschiedene Zwecke). Ch. Krämer. Illustrated description. 4000 w. Elektrotech Zeitschr —July 30, 1908. No. 94659 D.

Synchronous Motors.

The Synchronous Motor in Systems Operating at Low Power Factor. F. C. Helms. Discusses the advantages attending the use of a synchronous condenser for improving the power factor of a transmission system. 3500 w. Elec Wld —Aug. 22, 1908. Serial. 1st part. No. 94420.

The Circle-Diagram of the Synchronous Motor. F. Creedy. Describes a diagram which is analogous to the circle-diagram so well known in the case of the induction motor, single-phase series motor, etc. 1400 w. Elec Engr, Lond—July 31, 1908. Serial. 1st part. No. 94251 A.

ELECTRO-CHEMISTRY.

Corrosion.

The Rusting of Iron. J. Newton Friend. Reviews previous researches and account of investigations and conclusions. 8000 w. Jour Ir & St Inst—No. II, 1908. No. 94610 N.

Electro-Metallurgy.

Electric Furnace Reactions Under High Gaseous Pressures. R. S. Hutton and J. E. Petavel. Abstract from *Phil. Trans. of the Royal Soc.* Discusses results obtained, in research work. 2500 w. Elect'n, Lond—July 31, 1908. No. 94255 A.

See also Nickel, and Tin, under MINING AND METALLURGY, MINOR MINERALS.

Sea Water.

Artificial Sea Water. An illustrated account of the manufacture of sea water by the Hermite process, for use as a disinfectant in London slums. 2000 w. Sci Am—Aug. 8, 1908. No. 94225.

ELECTRO-PHYSICS.

Roentgen Tubes.

The Operation of Röntgen Tubes with Purely Unidirectional Induced Currents. Ernst Ruhmer. Lecture before the Deutsche Roentgen Gesellschaft. Describes the unidirectional arrangement, explaining its advantages. Ills. 1400 w. Elect'n, Lond—Aug. 7, 1908. No. 94366 A.

GENERATING STATIONS.

Accumulators.

The Care and Maintenance of Storage Batteries. F. A. Warfield. A discussion of their action, their troubles and the remedies. 2500 w. Elec Jour—Aug., 1908. No. 94293.

Storage Batteries, Their Construction and Uses. Percival Robert Moses. Discusses the utility of storage batteries in isolated plants, describing the structural and installation features of leading types. Ills. 3000 w. Engineering Magazine—Sept., 1908. Serial. 1st part. No. 94678 B.

Berlin.

The Berlin Electrical Works from 1902 to 1908 (Die Berliner Elektrizitäts-Werke von 1902 bis 1908). Herr Datterer. Describes recent extensions and improvements to the municipal stations. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—July 11, 1908. No. 94597 D.

Central Stations.

Generating End of Power Sations. A. D. Le Pan. A detailed discussion of present day practice. 4500 w. Can Engr—Aug. 7, 1908. No. 94242.

A Modern Steam Power Central Station on the Pacific Coast. Illustrated description of the plant at Redondo, Cal., where reciprocating engines are used in preference to turbines. 7800 w. Ind Wld —Aug. 24, 1908. No. 94485.

The Power System of the Georgia Railway & Electric Company. Illustrates and describes a power system at Atlanta, Ga., using steam, gas, and water power in the generation of electricity. 2500 w. Elec Ry Jour—Aug. 8, 1908. No. 94199.

The Yatesboro Power Plant of the Cowanshannock Coal & Coke Co. C. M. Means. Illustrated description of plants equipped with turbogenerators and motors using high voltage current. 3000 w. Mines & Min—Aug., 1908. No. 94073 C.

Electrical Generating System of the Newton Gas & Electric Company of Newton, N. J. Brief illustrated description of a station equipped with producer-gas engines belted to three-phase alternators. 1000 w. Elec Wld—Aug. 29, 1908. No. 94632.

Non-Synchronous Generator Stations of the Rheinbinnencanal, Switzerland. M. Yazidjian. Illustrated description of an

interesting installation, with an outline of the results obtained during the two years it has been in operation. 3000 w. Elec Wld—Aug. 15, 1908. No. 94327.

See also Interurban, under STREET AND ELECTRIC RAILWAYS.

Design.

The Operation of Electrical Machinery. Norman G. Meade. Gives suggestions to be followed when installing a new plant. 1200 w. Power—Aug. 18, 1908. No. 94378.

Hydro-Electric.

The Hydro-Electric Plant and Mill of the Superior Portland Cement Co., Superior, Wash. George H. Moore. Illustrated description. 1800 w. Eng Rec—Aug. 22, 1908. No. 94487.

Electric Power Development on Stanislaus River. Brief illustrated description of this project for generating electricity to be sold along the California coast. 1200 w. Cal Jour of Tech—Aug., 1908. No. 94607.

The Municipal Hydro-Electric Plant at Spooner, Wis. Illustrated description of a plant of special interest to small cities and towns because of its splendid financial showing. 1600 w. Eng Rec—Aug. 29, 1908. No. 94697.

Great Northern Power Company's Plant. Claude Aikens. Illustrated description of the great dam and waterways and some of the operating features of this hydraulic turbine installation. 4000 w. Power—Aug. 11, 1908. No. 94275.

The Hydro-Electric Development and Transmission Lines of the Canadian Niagara Power Company. A. H. Van Cleve. Remarks in regard to the history and general scope of the development, illustrating and describing the more important features of the plant. 11000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94671 E.

The Brusio Hydro-Electric Plant and its 50,000-Volt Swiss-Italian Transmission System. Frank Koester. Illustrated detailed description of a system showing modern European practice. 2500 w. Elec Rev, N Y—Aug. 8, 1908. Serial. 1st part. No. 94238.

Hydro-Electric Plant on the Tusciano, Italy (L'Usine Hydraulic-Electrique du Tusciano, Italie). M. de Kermond. Illustrated description. Serial. 1st part. 2200 w. L'Elecn—July 18, 1908. No. 94523 D.

An Electric Plant on the Avisio (Una Centrale Elettrica sull' Avisio). Description of a project involving the turning the waters of one river into another by means of a tunnel. Ills. 4500 w. Elettricita—July 30, 1908. No. 94538 D.

Location.

Pertinent Considerations on Power House Locations. E. D. Dreyfus. Gives a résumé of important considerations bearing on this subject. 2000 w. Elec Wld—Aug. 22, 1908. No. 94422.

Rates.

Diversity Factors. F. Fernie. Discusses the fixing of charges for electrical energy. 2000 w. Elect'n, Lond—July 24, 1908. No. 94152 A.

Switchboards.

A New Type of Switchboard: For the Salt River Project, U. S. Reclamation Service. Illustrated description. 1600 w. Eng News—Aug. 27, 1908. No. 94638.

Switch Gear.

Extra-High-Pressure Ironclad Switchgear. Illustrated description of a gear specially developed in conjunction with the Merz-Price system for feeder and transformer protection, although any other system may be used. 5000 w. Elec Rev, Lond—July 24, 1908. No. 94150 A.

Troubles of Central Station Switching Apparatus and Methods of Handling Them. C. F. Conrad. Considers troubles due to short circuits, troubles from overheated contacts, to breakdowns, etc. 4000 w. Elec Wld—Aug. 1, 1908. No. 94106.

LIGHTING.

Aluminium Cells.

A New Source of Illumination. G. A. Johnstone. A short description of phenomenon observed while experimenting with the aluminum alkaline electrolytic cell, and an application that has been made. 1800 w. Elec Wld—Aug. 15, 1908. No. 94328.

Hand Lamps.

Dangerous Electric Hand Lamps. Observations on some dangerous types in use. Ills. 1500 w. Mech Engr—July 31, 1908. No. 94250 A.

Helium Gas.

The Luminous Properties of Electrically Conducting Helium Gas. P. G. Nutting. An account of investigations made to determine the constancy and reproducibility of such a source of light. 2500 w. Bul Bureau of Stand—May, 1908. No. 94305 N.

Illumination.

See Theatres, under CIVIL ENGINEERING, CONSTRUCTION.

Incandescent Lamps.

Selective Radiation from the Nernst Glower. W. W. Coblentz. Gives methods and results of an investigation. 4000 w. Bul Bureau of Stand—May, 1908. No. 94307 N.

Conclusive Evidence of the "Overshooting" of Tungsten Lamps and Other Interesting Phenomena. J. Stuart Freeman. An illustrated account of investigations made. 1200 w. Elec Wld—Aug. 15, 1908. No. 94326.

Recent Achievements in Electric Light-

We supply copies of these articles. See page 159.

ing (Neuere Errungenschaften in der elektrischen Beleuchtung). W. Wedding. Gives a full account of a large number of tests on graphitized-carbon, tantalum and tungsten lamps. Ills. 4500 w. Elektrotech Zeitschr—July 30, 1908. No. 94658 D.

MEASUREMENT.

Dynamo E. M. F.

Determining the Electromotive Force of a Dynamo Without Running It. W. M. Hollis. Directions. 900 w. Elec Wld—Aug. 1, 1908. No. 94110.

Electrometers.

Function of a Periodic Variable Given by the Steady Reading of an Instrument; with a Note on the Use of the Capillary Electrometer with Alternating Voltages. Morton G. Lloyd. 1200 w. Bul Bureau of Stand—May, 1908. No. 94306 N.

Frequency.

See Power Factor, under MEASUREMENT.

Instruments.

The Electrical Testing Instruments of Messrs. Siemens Bros. & Co. Illustrated descriptions. 2000 w. Elect'n, Lond—July 24, 1908. Serial. 1st part. No. 94154 A.

Laboratories.

The Work and Equipment of a Testing and Standardizing Department. H. A. Ratcliff. Notes on various features of interest in connection with the testing department of electrical works. Ills. 2500 w. Elec Engr, Lond—July 24, 1908. Serial. 1st part. No. 94148 A.

Magnetic Flux.

An Apparatus for Determining the Form of a Wave of Magnetic Flux. M. G. Lloyd and J. V. S. Fisher. Illustrates and describes the apparatus and gives examples of its use. 2000 w. Bul Bureau of Stand—May, 1908. No. 94303 N.

Magnetization Curves.

Determination of the Magnetization Curves with Alternating Currents (Bestimmung des Magnetisierungsstromes bei Wechselstrom). O. S. Braystad and J. Liska. Mathematical discussion. Ills. 2500 w. Elektrotech Zeitschr—July 23, 1908. No. 94657 D.

Meter Testing.

The Test-Meter Method of Testing Service Meters. Joseph B. Baker. An explanation of this method of testing, discussing its merits and defects. 1000 w. Elec Rev, N Y—Aug. 8, 1908. Serial. 1st part. No. 94237.

Power Factor.

The Measurement of Power Factor and Frequency in Single-Phase Alternating-Current Circuits. Dr. W. Lulofs. Explains methods. Mathematical. 1500 w. Elect'n, Lond—Aug. 14, 1908. No. 94465 A.

Three-Phase Power Factor by Single-Phase Wattmeter. Nicholas Stahl. Gives three methods that are recommended for determining three-phase power-factors. 1800 w. Elec Wld—Aug. 29, 1908. No. 94633.

Resistance.

Resistance and Impedance. W. B. Kouwenhoven. An explanation of resistance and its measurement. 1800 w. Ry & Loc Engng—Aug., 1908. No. 94102 C.

Standardization.

Standardization Apparatus for Measuring Volts, Amperes and Watts. E. F. Northrup. Discusses the present status of standardization apparatus used in the measurement of volts, amperes, and watts. Ills. 8500 w. Jour Fr Inst—Aug., 1908. No. 94294 D.

TRANSMISSION.

Alternating Currents.

Amperes in Alternating-Current Circuits. A. D. Williams, Jr. Presents tables giving the amperes per lead wire per kilowatt for single-phase and three-phase balanced loads, with notes. 1500 w. Elec Wld—Aug. 8, 1908. No. 94210.

Cables.

Localizing High-Resistance Breaks in Cables. J. Rymer-Jones. Describes a method revised and simplified from an earlier method devised by the writer. 2200 w. Elec Rev., Lond—July 24, 1908. Serial. 1st part. No. 94149 A.

High-Tension Cables and High-Tension Power Transmission. R. Apt. Abstract of paper read before the Elektrotechinischer Verein. Discusses insulating materials, losses in the lead, deducing formula for the same, etc. 2500 w. Elect'n, Lond—Aug. 14, 1908. No. 94466 A.

Excess Voltages.

Excess Voltage Analogies (Praktische Ueberspannungsanalogien). Iwan Döry. Compares excess voltages produced in transmission lines at the moment of switching, etc., with excessive pressures in hydraulic systems following sudden changes in the turbine load. Mathematical. Ills. 4500 w. Elektrotech Zeitschr—July 16, 1908. No. 94655 D.

Insulation.

Disruptive Strength and Temperature (Durchschlagsspannung und Temperatur). A. Grau. A discussion of the relation between them based on tests. Ills. 3200 w. Elektrotech u Maschinenbau—July 5, 1908. No. 94592 D.

Lightning.

Lightning Phenomena. E. E. F. Creighton. A general review of important results of the study of lightning phenomena is given in the present article. 2200 w. Elec Wld—Aug. 8, 1908. Serial. 1st part. No. 94207.

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Lightning Arresters.

The Resistance of Lightning Arrester Earth Connections. E. E. F. Creighton. Reports a series of tests made and their results. 2500 w. Elec Wld—Aug. 22, 1908. No. 94421.

Losses.

See Cables, under TRANSMISSION.

Oscillations.

Free Oscillations in Long Transmission Lines (Freie Schwingungen in langen Leitungen). Karl Willy Wagner. Mathematical paper on the oscillations following sudden changes in voltage. Ills. 4500 w. Elektrotech Zeitschr—July 23, 1908. No. 94656 D.

Protective Devices.

Protective Devices. H. B. Gear and P. F. Williams. Discusses this problem in connection with the development of power stations in very large capacity, and the great increase in voltage. Ills. 5000 w. Elec Age—Aug., 1908. No. 94289.

Substations.

Large Typical Substation of the Chicago City Railway. Illustrated detailed description of a large rotary converter substation. 2500 w. Elec Ry Jour—Aug. 15, 1908. No. 94325.

Transformer.

A Convenient Experimental Transformer. George T. Hanchett. Gives a simple plan of making a transformer of variable voltage out of material at hand. 800 w. Elec Wld—Aug. 1, 1908. No. 94108.

Effect of Wave Form Upon the Iron Losses in Transformers. Morton G. Lloyd. Considers the problem from the theoretical standpoint, gives results of experimental investigations, and conclusions. 6000 w. Bul Bureau of Stand—May, 1908. No. 94304 N.

Voltage Regulation.

Alternating-Current Potential Regulators. George R. Metcalfe. Describes the induction type regulator, and the step-by-step regulator, and their operation. Ills. 3500 w. Elec Jour—Aug., 1908. No. 94292.

MISCELLANY.

Agriculture.

Electricity in Agriculture. Sir Oliver Lodge. Gives a report of experiments made on a commercial scale. Ills. 3800 w. Elec Engr, Lond—July 24, 1908. No. 94146 A.

Development.

The Industrial Evolution of Electricity (L'Evoluzione industriale dell' Elettrotecnica). G. Bartoli. A general review. Ills. Serial. 1st part. 8000 w. Riv Marit—July-Aug., 1908. No. 94537 E + F.

Electric Target.

The Rose Recording Target. Describes a target for range firing which dispenses with markers. Ills. 1200 w. Elec Engr, Lond—July 31, 1908. No. 94252 A.

Resistances.

A Satisfactory Form of High Resistance. G. W. Stewart. An account of experiments made with lampblack mixed with lacquer known as "Zapon L." 1100 w. Elect'n, Lond—Aug. 14, 1908. No. 94464 A.

Groups of Incandescent Lamps Used as Constant Resistors. A. C. Stevens. Reports results of tests made with incandescent lamps with metallic filaments. 900 w. Elec Wld—Aug. 1, 1908. No. 94107.

Synchronous Devices.

Synchronous Devices and Their Uses (Appareils de Synchronisme et leurs Utilisations). M. Conrade. Describes the principles of synchronism and shows its application to devices for controling phonographs, cinematographs, and other uses. Ills. 6500 w. Mem Soc Ing Civ de France—June, 1908. No. 94508 G.

INDUSTRIAL ECONOMY

Apprenticeship.

The Crisis of Apprenticeship (La Crise de l'Apprentissage). M. de Ribes-Christofle. Outlines the causes and effects of the decline of apprenticeship in France. 2500 w. Bul Soc d'Encour—June, 1908. No. 94515 G.

Cost Systems.

Obtaining Actual Knowledge of the Cost of Production. F. E. Webner. This fifth article considers the organization of a cost department. 2500 w. Engineering Magazine—Sept., 1908. No. 94677 B.

A Uniform Foundry Cost System. Ellsworth M. Taylor. Read before Am. Found. Assn. A memorandum on foundry costs prepared by the Cost Committee of the American Foundry Assn. 2500 w. Foundry—Aug., 1908. No. 94188.

The Proper Use of Cost-Keeping Systems. Sterling H. Bunnell. Explains the value of such systems when properly used, and the causes of their proving unsatisfactory in certain cases. 2200 w. Cassier's Mag—Aug., 1908. No. 94173 B.

Education.

Technical Education in Scotland at the Franco-British Exhibition. John G. Kerr. Describes the Scotch exhibit. 2000 w. Engng—Aug. 14, 1908. No. 94471 A.

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The Technical Schools' Exhibits at the Franco-British Exhibition. Joseph Horner. Describes the exhibits of the British technical schools, and outlines the work of the various schools. Ills. 4000 w. Engng—July 31, 1908. Serial. 1st part. No. 94264 A.

Secondary Mining Education. H. H. Stoek. An account of what has been accomplished in the United States and Canada. Discussion. 8000 w. Qr Bul of Can Min Inst—July, 1908. No. 94396 N.

Instruction in Economics and Sociology in Technical Schools (L'Enseignement économique et social dans les Ecoles techniques). Maurice Bellom. Demonstrates its necessity and reviews courses in French and foreign schools. Serial. 1st part. 2200 w. Génie Civil—July 4, 1908. No. 94531 D.

Engineering.

The Evolution of Engineering. Henry Gordon Stott. Presidential address. 2000 w. Pro Am Inst of Elec Engrs—Aug., 1908. No. 94297 D.

Filing Systems.

The Filing System of the New York Board of Water Supply. J. Leo Murphy. Considers the requisites of a good filing system and describes the system used by the N. Y. Board of Water Supply. 7500 w. Eng News—Aug. 6, 1908. No. 94221.

Germany.

Industrial Economy in Germany (Les Procédés de l'Industrie Allemande). Victor Cambon. Outlines the great development of Germany's trade and the influence on it of technical education, railways, ports, financial system, government regulation, etc. Ills. 1400 w. Mem Soc Ing Civ de France—April, 1908. No. 94502 G.

Industrial Villages.

The Industrial Village at Roebling, N. J. A description of the lay out of the village, the buildings, etc., with illustrations. 4500 w. Ir Age—Aug. 6, 1908. No. 94178.

A Model Colliery Village. Illustrated description of the Brodsworth Main Colliery Co.'s housing scheme. 1500 w. Col Guard—Aug. 14, 1908. No. 94470 A.

Japan.

Machinery Building in Japan. A. Gwaikokuijin. Information concerning the exports and works. 1000 w. Am Mach—Vol. 31. No. 35. No. 94628.

Labor.

A Superintendent's Views of American Shop and Labor Conditions. John George Niederer. An estimate of educational and union tendencies. 1200 w. Engineering Magazine—Sept., 1908. No. 94684 B.

Cost of Living of the Working Classes in Germany. Information from a recent volume issued by the Board of Trade reporting results of investigations of the cost of housing, prices of commodities, with rates of wages, and general industrial conditions. 3000 w. Ir & Coal Trds Rev—July 24, 1908. No. 94171 A.

Management.

Manufacturing from Stock. Clarence Hoyt Stilson. Discusses principles and methods of the stock-limit system and its advantages. 1400 w. Engineering Magazine—Sept., 1908. No. 94680 B.

Efficiency as a Basis for Operation and Wages. Harrington Emerson. This third article of a series discusses the strength and weakness of existing systems of organization. 5500 w. Engineering Magazine—Sept., 1908. No. 94685 B.

Accounting for Labor and Material. Oscar E. Perrigo. Eleventh of a series of articles on cost-keeping and shop management. Ills. 3500 w. Ir Trd Rev—Aug. 13, 1908. No. 94333.

Notes on Industrial Management (Einzelfragen aus der Organisation technischer Betriebe). F. A. Neuhaus. Discusses the keeping of records, cost accounting, etc. Ills. Serial. 1st part. 3800 w. Zeitschr d Ver Deutscher Ing—July 18, 1908. No. 94599 D.

See also Purchasing, under INDUSTRIAL ECONOMY.

Patents.

The Working Requirement in Patent Law. John D. Morgan. Discusses the advisability of the United States enacting such a requirement. 3500 w. Ir Age—Aug. 20, 1908. No. 94403.

The Mission of the Patent Attorney (De la Mission de l'Agent de Brevets). G. van der Haeghen. Serial. 1st part. 3000 w. All Indus—July, 1908. No. 94526 D.

Purchasing.

The Engineer as a Purchasing Agent. James M. Cremer. Shows the advantages of engineering experience in the purchasing of supplies. 6500 w. Cassier's Mag—Aug., 1908. No. 94174 B.

Wages.

The Payment of Wages. Forrest E. Cardullo. Reply to Harrington Emerson's criticism of the writer's article on this subject. 3500 w. Ir Trd Rev—Aug. 20, 1908. No. 94414.

A Remarkable Piece Work Document. Information supplied by the mechanical superintendent of a large railroad, showing the advantages of the system. 3000 w. R R Age Gaz—Aug. 14, 1908. No. 94352.

The Taylor and Barth Slide-Rules for the Application of the Taylor System of Management (Les Regles et Circles à Calcul de Fred W. Taylor et Carl G. Barth pour l'Application du Système Taylor dans l'Atelier de Mécanique). L. Descroix. Describes the calculating rules and their use. Ills. 6500 w. Rev de Métal—July, 1908. No. 94513 E + F.

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MARINE AND NAVAL ENGINEERING

Battleships.

French Warship Construction. Editorial review of a paper by C. Ferrand on the importance of the time occupied in the construction of ships. 2500 w. Engng—July 24, 1908. No. 94162 A.

The New Brazilian Battleships and Their Armor. Particulars of the vessels, with details of the armor-plate trials, showing the reliability of the material. 1200 w. Engng—Aug. 14, 1908. No. 94476 A.

The Race for Naval Power. Archibald S. Hurd. A survey of the naval activity of the world, discussing the shipbuilding programmes of the great naval powers. Ills. 3500 w. Cassier's Mag—Aug., 1908. No. 94176 B.

Cables.

The Disappearance of Manila Lines on Board Ships. Robert Sanford Riley. An illustrated account of the machinery used in connection with steel wire cables, which have largely superseded ropes. 1500 w. Int Marine Engng—Sept., 1908. No. 94662 C.

Compasses.

The General Theory of Corbara's Quadrantal Compensation, with Notes on a More Suitable Compass for War Vessels (Sulla Teoria generale della Compensazione quadrantale del Corbara con alcune Considerazioni sui Tipi di Bussola piu Convenienti alle Navi da Guerra). Luigi Tonta. Ills. 12000 w. Riv Marit—July-Aug., 1908. No. 94536 E + F.

Cruisers.

Trial Performance of Three United States Scout Cruisers. An account of trials of vessels having totally different modes of propulsion; one having reciprocating engine; a second Parsons turbines; and the third Curtis turbines. Ills. 2200 w. Int Marine Engng—Sept., 1908. No. 94661 C.

Electric Power.

The Generation and Electrical Transmission of Power for Main Marine Propulsion and Speed Regulation. William P. Durtnall. Abstract of paper before the Inst. of Marine Engrs., Franco-British Ex. Considers the possibilities and advantages of the steam-electric system of power generation and transmission for marine propulsion. Ills. 4000 w. Elec Engr, Lond—July 24, 1908. No. 94147 A.

Ferry Boats.

The Elevating Ferry-Steamer "Finniesston," for Glasgow Harbor. Illustrated description. 700 w. Engng—Aug. 14, 1908. No. 94477 A.

See also English Channel, under CIVIL ENGINEERING, WATERWAYS AND HARBORS.

Hospital Ships

The Boston Floating Hospital. Robert Charles Monteagle. Plans and illustrated description of the new vessel launched in 1906. 3000 w. Int Marine Engng—Aug., 1908. No. 94089 C.

Japan.

Progress of Ship-Owning in Japan. Reviews the history of Japanese shipping. 2000 w. Engng—Aug. 14, 1908. No. 94472 A.

Launching.

Launching a Great Lakes Freighter. Ralph E. Flanders. Illustrates and describes the method of supporting the hull on land and of launching it. 2200 w. Mach, N Y—Aug., 1908. No. 94112 C.

Ship Design.

The Most Successful Dimensions of Steamships in Relation to Economy. Otto Alt. An examination in detail of this problem. 2500 w. Int Marine Engng—Aug., 1908. Serial. 1st part. No. 94090 C.

The Interrelation of Theory and Practice of Shipbuilding. J. J. O'Neill. Read before the Inst. of Engrs. & Shipbldrs. in Scotland. Examines only the speed-power aspect of the question. 4000 w. Engr, Lond—July 24, 1908. No. 94169 A.

The Shape of Ships' Bottoms (La Forme des Carènes). Ch. Weyher. Criticises the practice of making the stern more slender than the stern. Ills. 3600 w. Rev Gen des Sci—July 30, 1908. No. 94517 D.

Steamers.

The Lake Passenger Steamer City of Cleveland. Illustrated detailed description of the vessel and its equipment. 2200 w. Int. Marine Engng—Sept., 1908. No. 94660 C.

Steamships.

Editorial Correspondence from Abroad. Angus Sinclair. Notes containing reference to engineering features of the "Columbia." 2200 w. Ry & Loc Engng—Aug., 1908. No. 94104 C.

The Isle of Man Turbine Steamer "Ben-my-Chree." Illustration, drawings, and description of what has proved the fastest Channel steamer afloat. 1500 w. Engng—Aug. 14, 1908. No. 94473 A.

Steam Turbines.

The A. E. G. Curtis Turbine with Special Reference to the Marine Type (Die A. E. G.-Curtis-Turbine, unter besonderer Berücksichtigung der Schiffsturbine).

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Carl Züblin. Describes this type of turbine and its applications. Ills. 3000 w. Die Turbine—July 20, 1908. No. 94568 D.

See also Steamships, under MARINE AND NAVAL ENGINEERING.

Torpedo Boats.

Torpedo-Boat for the Bulgarian Government. Explains the difficulties in the scheme for defending their coast on the Black Sea, the final construction of the boats in France, the putting down of a re-erecting yard at Varna, including a launching and hauling-up slip, etc. 1200 w. Engng—July 31, 1908. No. 94269 A.

MECHANICAL ENGINEERING

AUTOMOBILES.

Apperson.

Apperson Small Car, 1909. Illustrated description of "Model O," a new car of the medium-powered type, to sell at a low price. 500 w. Automobile—Aug. 13, 1908. No. 94336.

Ariel.

The 20-H.P. Ariel Touring Car or Town Carriage. Illustrated detailed description. 2000 w. Auto Jour—Aug. 15, 1908. No. 94446 A.

Benz.

The 1908 Benz Petrol Cars. Illustrated detailed description of a 28-h.p. live-axle car. 1200 w. Auto Jour—Aug. 1, 1908. Serial. 1st part. No. 94247 A.

Cabs.

Cars for Passenger Use in and About Cities. Compares the requirements of the taxicab and the town car, and matters related. Ills. 3500 w. Automobile—Aug. 6, 1908. No. 94195.

Competitions.

The Motor Trials of the Scottish Automobile Club. An editorial review of these trials, with tabulated information and results. 3500 w. Engng—July 31, 1908. No. 94267 A.

The *Grands Prix* of the Automobile Club of France in 1908 (Grands Prix de l'Automobile-Club de France en 1908). M. Girardault. Details of the competing cars and of the races. Ills. 3000 w. Génie Civil—July 18, 1908. No. 94532 D.

Farm Motors.

California Advanced in Motor Farm Machinery. Victor Lougheed. Brief account of the success with farm tractors and similar agricultural implements. Ills. 1500 w. Automobile—Aug. 6, 1908. No. 94196.

Franklin.

Franklin Motor Cars for 1909. Illustrates and describes improvements made in details of these cars. 2500 w. Automobile—Aug. 27, 1908. No. 94644.

Fuels.

Benzol as an Automobile Fuel. (De l'Emploi du Benzol dans les Moteurs d'Automobiles). A. Grebel. An exhaustive discussion of the properties of benzol and its use as a motor fuel. Ills. 16000 w. Mem Soc Ing Civ de France—May, 1908. No. 94505 G.

Hillman-Coatalen.

The 12-15 H. P. Hillman-Coalalen Car. Illustrated detailed description. 1200 w. Autocar—Aug. 8, 1908. No. 94358 A.

Ignition.

Gearless Magnetos. Gives illustrated descriptions of the Henrique, and the Nieuport magnetos. 2200 w. Autocar—Aug. 15, 1908. No. 94449 A.

The Relation Between Power and Spark. W. Watson. Gives results of experiments on the influence of the character of the spark on the power developed, and the effects of using two sparks. 2000 w. Autocar—July 25, 1908. No. 94134 A.

Low-Priced.

Concerning the Eleventh Year Automobiles. Thomas J. Fay. The present discussion deals only with the lower-priced cars, claiming that they are the best the builders have ever turned out. Ills. 3500 w. Automobile—Aug. 13, 1908. Serial. 1st part. No. 94334.

Mercedes.

The 35-H.P. Live-Axle Mercedes. An illustrated detailed description of a model embodying many uncommon principles in design. 1200 w. Auto Jour—Aug. 1, 1908. Serial. 1st part. No. 94246 A.

Motors.

Valve Positions in Petrol Motors. Bertram C. Jay. Discusses the question from the point of view of the working conditions inside the combustion chamber. 1600 w. Autocar—Aug. 15, 1908. No. 94450 A.

What Is the Best Relation of Bore to Stroke? Gerard Laverque. Shows the importance of the stroke as a factor in the power of a motor, discussing particularly the long stroke. 2800 w. Automobile—Aug. 27, 1908. No. 94643.

Omnibuses.

The London Motor Omnibus Problem. Bernard Hopps. Abstract of a paper before the Rugby Engng. Soc. A brief summary of London's motor omnibus development with discussion of the petrol-electric system. 2500 w. Auto Jour—Aug. 15, 1908. No. 94448 A.

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Panhard.

The 15 H. P. Chainless Panhard. Illustrated description of new features introduced. 1600 w. Autocar—Aug. 1, 1908. No. 94248 A.

Speed Regulation.

Governing the Speed of Motor Vehicles. Morris A. Hall. Considers the mechanical methods by which overspeeding may be prevented. 2500 w. Com Vehicle—Aug., 1908. No. 94311 C.

Tires.

The Torkington Solid Rubber Tyre. Illustrates and describes the construction of a new form of tyre that can be used for heavy, high-speed touring vehicles. 3000 w. Auto Jour—July 25, 1908. No. 94136 A.

A New Pneumatic Tire for Heavy Loads (Nouveau Dispositif de Pneumatique pour Poids lourds). A. Michelin. Discusses the advantages of a tire consisting practically of two tires joined together. Ills. 2300 w. Mem Soc Ing Civ de France—April, 1908. No. 94501 G.

The Action and Wear of Solid Rubber Tires on Industrial Vehicles (Mode d'Action et Usure des Bandages Pleins en Caoutchouc, sur les Automobiles Industrielles). E. Girardault. Ills. Serial. 1st part. 1500 w. Génie Civil—July 25, 1908. No. 94535 D.

Tractors.

War Office Competition for Light Tractors. Gives the requirements to be fulfilled, with editorial. 4000 w. Engng—July 24, 1908. No. 94163 A.

Wheels.

The Wicks Resilient Wheel. Illustrates and describes an invention of F. Wicks aiming to render suitable the use of steel tires on motor omnibuses and other heavy vehicles. 800 w. Auto Jour—Aug. 15, 1905. No. 94447 A.

Wire and Wood Wheels. Gives results of impact tests on the two types of wheels, which seem to demonstrate that wire wheels are able to withstand modern heavy side stresses better than wooden wheels. Ills. 1200 w. Autocar—July 25, 1908. No. 94135 A.

White.

The 1909 White Steam Cars. Illustrated descriptions of Models M and O, of 40 and 20 h.p. respectively. 2000 w. Automobile—Aug. 27, 1908. No. 94645.

Winton.

Winton Sixes for 1909. Illustrated description of features of new 6-cylinder cars. 1200 w. Automobile—Aug. 6, 1908. No. 94197.

COMBUSTION MOTORS.

Fuels.

Alcohol as a Fuel for Internal-Combustion Engines. Thomas L. White. This concluding article considers its practical carburation and adaptation as a gasoline substitute. 5000 w. Engineering Magazine—Sept., 1908. No. 94681 B.

Gas Engines.

The Turner-Fricke Gas Engine. Illustrates and describes some improvements introduced. 1500 w. Ir Age—Aug. 20, 1908. No. 94404.

Gasoline Engines.

See Motors, under AUTOMOBILES.

Gas Power Plants.

See Gas Producers, under COMBUSTION MOTORS; Power Plants, under POWER AND TRANSMISSION; and Plants, under MINING AND METALLURGY, MINING.

Gas Producers.

Suction Gas Producer for American Coals and Lignites. L. P. Tolman. Brief review of the early history of producer gas, with illustrated description of suction gas power plants in single circuits of 200 h.p., or smaller, and complete plants of 1000 h.p. or larger. 4000 w. Ind Wld—Aug. 10, 1908. No. 94243.

Progress in Use of Suction Gas Producer Power. L. P. Tolman. Discusses the efficiency and economy of producer gas power plants; the development and types of the suction gas producer. Ills. 3500 w. Min Wld—Aug. 15, 1908. No. 94357.

Important Considerations in the Construction and Operation of Gas Producer Plants for Open-Hearth Steel Plants (Wichtige Gesichtspunkte für den Bau und Betrieb von Gaserzeugeranlagen bei Martinwerken). C. Canaris. 4500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 18, 1908. No. 94560 D.

Oil Engines.

See Pumping Plants, under HYDRAULIC MACHINERY.

HEATING AND COOLING.

Air Humidifying.

Air Washing and Humidifying, and Some of Its Applications to Industrial Purposes. W. A. Rowe. Condensed from paper read before the Ohio Soc. of Mech., Elec., & Steam Engrs. Discusses methods of adding moisture to air and also dehumidifying air. 1500 w. Eng News—Aug. 13, 1908. No. 94321.

Electric Heating.

Electric Heating and Cooking (Das elektrische Heizen und Kochen). E. R. Ritter. A description and comparison of systems and appliances. Ills. Serial. 1st part. 3800 w. Gesundheits-Ing—July 18, 1908. No. 94579 D.

Exhaust-Gas Heating.

A Heating System Utilizing the Waste Heat of a Gas Engine. F. C. Tryon. Describes a successful system of utilizing the waste heat for heating the buildings. Ills. 1000 w. Power—Aug. 4, 1908. No. 94127.

Hot-Water Heating.

Combined Power and Hot Water Heating Plant. Charles L. Hubbard. Illustrated description of the arrangement of the special apparatus and operation of the plant. 1500 w. Power—Aug. 25, 1908. No. 94601.

Rapid-Circulation Hot-Water Heating (Chauffage à Niveau et à Circulation accélérée). L. d'Anthonay. Describes and compares the principal systems, outlines the advantages and disadvantages of each and gives note on the cost of installation and operation. Ills. 5200 w. Mem Soc Ing Civ de France—May, 1908. No. 94504 G.

Houses.

Important Considerations in House Heating. From an article by E. D. Sidman, in *Building Management.* On the proper equipment and arrangement of house heating apparatus. 1500 w. Met Work—Aug. 22, 1908. No. 94432.

Refrigeration.

Ice Making and Refrigeration in Japan. Tatsujiro Uchimura. A brief account of the beginnings of this industry. 1200 w. Ice & Refrig—Aug., 1908. No. 94080 C.

Jacket Water on Single Acting Compressors. John E. Starr. Practical tests and deductions, explaining why jacket water is of little value. 2500 w. Ice & Refrig—Aug., 1908. No. 94079 C.

School Buildings.

Heating and Ventilation of School Buildings. Walter B. Snow. Describes a double-duct system of indirect heating. Ills. 2400 w. Power—Aug. 4, 1908. No. 94129.

Ventilation.

Purification of Air by Means of Ozone. Dr. G. Erlwein. An illustrated description of new ozone apparatus for ventilation. 900 w. Sci Am Sup—Aug. 15, 1908. No. 94338.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

High Pressure Centrifugal Pumps (Les Pompes centrifuges à haute Pression). D. Banki. A translation into French of an article which appeared in the *Zeitschr. d. Oest. Ing. u. Arch. Vereines,* in 1903. Ills. 5500 w. Rev. de Mécan—July, 1908. No. 94521 E + F.

A Criticism of Biel's Work on Centrifugal Pumps and Fans (Kritik der Bielschen Arbeit über Kreiselpumpen und Ventilation). E. Eickoff. A criticism of a paper by R. Biel published in *Zeitschr. d. Ver. Deutscher Ing.* for March 21, 1908, *et seq.* Ills. Serial. 1st part. 1500 w. Die Turbine—July 20, 1908. No. 94569 D.

Hydrostatics.

Hydrostatics, or the Equilibrium of Fluids. Franklin van Winkle. Considers facts concerning compressibility of liquids, the transmission of pressure through them, head and pressure due to gravity, etc. Ills. 2400 w. Power—Aug. 11, 1908. No. 94279.

Pumping.

See same title, under MINING AND METALLURGY, MINING.

Pumping Plants.

The New Sewage Pumping Station, Washington, D. C. Illustrated detailed description of the station and its equipment. 4000 w. Eng Rec—Aug. 22, 1908. No. 94486.

Operating Results of the Wrentham and Wareham Fuel-Oil Pumping Stations. Information furnished by Edmund M. Blake concerning the operation and results of tests of these Massachusetts plants. Ills. 1200 w. Eng Rec—Aug. 29, 1908. No. 94687.

See also Pipe Lines, under CIVIL ENGINEERING, WATER SUPPLY.

Pumps.

Direct - Acting Compound - Condensing Steam-Pump. Brief detailed description, with illustrations. 300 w. Engng—July 31, 1908. No. 94268 A.

Turbine Governing.

The Glocker-White Turbine Governor. W. M. White and L. F. Moody. Illustrated description of a water-wheel governor having hollow balls containing a shifting charge of mercury. 2500 w. Power—Aug. 4, 1908. No. 94131.

Turbines.

Hydraulic Turbine Wear and Corrosion. Edward P. Buffet. An illustrated report of results of an investigation of abnormal wear, abrasion and corrosion of water turbines. 2000 w. Power—Aug. 4, 1908. No. 94128.

The Francis Turbine (Die Francis-Turbine). Adolf Knelles. A mathematical demonstration of the method of design. Ills. 3000 w. Elektrotech Rundschau—July 10, 1908. No. 94589 D.

Tests of a Lorenz Turbine (Versuche an einer Lorenz-Turbine). Ernst Reichel. Describes machine and tests and gives results in curves and tables. Ills. Serial. 1st part. 4500 w. Zeitschr f d Gesamte Turbinenwesen—July 10, 1908. No. 94570 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Modern Ball Bearings and Their Applications (Die heutigen Kugellager und ihre Anwendung). Aug. Bauschlicher. Illustrated discussion of new applications and developments. Serial. 1st part. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94652 D.

Crank Shafts.

Crank Shafts. Norman S. Trustrum. A study of stresses in a moving crank. Ills. 1200 w. Mech Engr—Aug. 14, 1908. Serial. 1st part. No. 94458 A.

We supply copies of these articles. See page 149.

Flywheels.

The Functions of Flywheels. H. M. Sayers. Discusses flywheel effects and the purposes for which they are used. 3500 w. Elec Engng—Aug. 13, 1908. No. 94460 A.

Machine Frames.

The Designing of Machine Frames. E. A. Fessenden. Discusses a method of designing, explaining calculations and stating the advantages of this method. Ills. 3500 w. Mach, N Y—Aug., 1908. No. 94113 C.

Springs.

Sizes of Helical Springs without Mathematics. A. T. Nickerson. Gives charts for finding the proportions, illustrating their use by examples. 1200 w. Am Mach—Vol. 31, No. 33. No. 94314.

MACHINE WORKS AND FOUNDRIES.

Annealing.

Annealing Grey Iron Castings. Walter J. May. Explains the advantages gained by removing the casting stresses. 800 w. Prac Engr—Aug. 14, 1908. No. 94457 A.

Boring Machines.

A Jig Boring Machine of English Design. J. W. Chubb. Illustrated description of a vertical spindle tool using end measuring rods and micrometer adjusting devices. 2500 w. Am Mach—Vol. 31. No. 34. No. 94405.

Brass Founding.

New Brass Casting Regulations. New regulations, in Circ. 484, issued by the British Home Secretary. 1200 w. Ir & Coal Trds Rev—July 31, 1908. No. 94274 A.

Value of Liquid Fuel in Brass Foundry Practice. W. N. Best. Read before the Am. Brass Found. Assn. Considers burners for liquid fuel, regulating devices, air consumption, supply tank, etc. 1500 w. Foundry—Aug., 1908. No. 94187.

Burnishing.

Some Notes on Machine Burnishing. Illustrated descriptions of various burnishing machines with remarks on their operation. 1500 w. Brass Wld—Aug., 1908. No. 94386.

Castings.

See Annealing, under MACHINE WORKS AND FOUNDRIES.

Cupolas.

A Study of Cupola Blast Pressures. Walter B. Snow. Compares results of a series of forty-six recent tests. 1400 w. Foundry—Aug., 1908. No. 94189.

Chemical Reactions in Cupola Practice. Jules De Clercy. Read before the Am. Found. Assn. Examines experimental results giving conclusions concerning the conditions most suitable for the proper operation of a cupola. 2000 w. Found—Aug., 1908. No. 94191.

Cutting Tools.

Internal Cutting Tools for Screw Machines. C. L. Goodrich and F. A. Stanley. Illustrates and describes the spotting tools and drills used for starting holes, which are completed by drills, reamers and counterbores of various types. 2000 w. Am Mach—Vol. 31. No. 35. No. 94629.

Emery Wheels.

The Manufacture of Emery Wheels. Illustrates and describes the process as carried out at a new plant at Rochester, Pa. 1500 w. Ir Trd Rev—Aug. 13, 1908. No. 94332.

Filing.

How to Handle a File. W. A. Knight. Hints of value in regard to filing flat, concave and convex surfaces, and filing out a slot. Ills. 2000 w. Mach., N Y—Aug., 1908. No. 94115 C.

Foundry Materials.

See Metallurgy, under MATERIALS OF CONSTRUCTION.

Foundry Practice.

Malleable-Iron Founding. F. R. King. Describes the production of iron castings by the English or Reamur system. 1500 w. Mech Wld—Aug. 14, 1908. No. 94456 A.

Furnaces.

Electric Furnaces Used in Treating Steel. E. F. Lake. Different styles of furnaces are illustrated and described. 2000 w. Am Mach—Vol. 31. No. 33. No. 94316.

A Crucible Furnace Embodying a New Principle. Illustrated description of an oil-burning furnace invented by W. S. Rockwell. 1000 w. Brass Wld—Aug., 1908. No. 94388.

The Kroeschell-Schwartz Gyrating-Flame Crucible Furnace. Illustrated description of a new type invented by E. H. Schwartz. 400 w. Brass Wld—Aug., 1908. No. 94389.

See also Brass Founding, under MACHINE WORKS AND FOUNDRIES.

Galvanizing.

Galvanizing. Translated from Friedrich Hartmann's book, "Das Verzinnen, Verzinken, etc., der Metalle," giving practical suggestions. 1700 w. Sci Am Sup—Aug. 29, 1908. Serial. 1st part. No. 94642.

Gear Cutting.

A New Eberhardt Gear Cutter. Illustrates and describes an automatic machine for doing a wide range of work. 1700 w. Ir Age—Aug. 27, 1908. No. 94624.

The Evolution and Methods of Manufacture of Spur-Gearing. Thomas Humpage. An illustrated historical review of the development of gear-cutting machinery. 9000 w. Inst of Mech Engrs—July 28, 1908. No. 94262 N.

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A New English Gear-Cutting Machine. J. W. Chubb. The work is rotated and moved up and down past rack tooth shaped cutters. Ills. 700 w. Am Mach—Vol. 31. No. 32. No. 94184.

Grinding.

Practical Points in Cylindrical Grinding. J. J. Thatcher. Considers the economy of roughing out in the lathe prior to grinding, and the advantages of higher work speeds. 2500 w. Am Mach—Vol. 31. No. 34. No. 94406.

A New Idea for Disk Grinders with Tests. F. N. Gardner. Illustrates and describes corrugated disks presenting points of abrasion. Gives comparative test results. 1700 w. Am Mach—Vol. 31. No. 32. No. 94185.

Grinding Machines.

Guest's Grinding Machines. Illustrated detailed description of a machine manufactured at Birmingham, Eng. 2200 w. Engng—Aug. 14, 1908. No. 94474 A.

Lathes.

The Bench Lathe as a Manufacturing Tool. F. A. Stanley. Illustrates and describes how dial-measuring gages and other tools are machined in bench lathes and tested with special devices. 2200 w. Am Mach—Vol. 31, No. 33. No. 94313.

Machine Tools.

A Machine for Milling, Grinding, Slotting, and Punching Cylindrical Machine Parts (Machine à Fraiser, Polir, Rainer, et Percer des Piéces Cylindriques de Machines). Illustrated description. 1700 w. Métallurgie—July 1, 1908. No. 94528 D.

Machine Tools at the International Automobile Exposition in Berlin, 1907 (Die Werkzeugmaschinen auf der internationalen Automobilausstellung in Berlin, 1907). Illustrated description of various models. Serial. 1st part. 3000 w. Zeitschr f Werkzeug—July 25, 1908. No. 94573 D.

Molding.

Spacing and Mounting Patterns. Alex. M. Thompson. Paper before the Ass. Found. Foremen. Gives a new means of quickly spacing and attaching patterns on the mold board. Ills. 2000 w. Mech Wld—Aug. 7, 1908. No. 94364 A.

Rack Cutting.

A Method of Cutting Racks on a Planer. Howard Hunt. Illustrated description. 700 w. Am Mach—Vol. 31. No. 35. No. 94631.

Shop Appliances.

Master Plates and Their Uses in Die Making. E. H. Crosby. Illustrates and describes methods used in producing master plates, and their use in actual shop practice. 3000 w. Am Mach—Vol. 31. No. 32. No. 94182.

Making Tools for Formed Gear Cutters and Hubs. Warren E. Thompson. The application of templets, fly cutters, formed tools and fixtures to the solution of the formed cutter problem. 5000 w. Am Mach—Vol. 31. No. 34. No. 95407.

Shops.

The Newark and Victoria Works, Bath. Illustrations and brief description of the works of Stothert and Pitt, Ltd. 2500 w. Engr, Lond—Aug. 7, 1908. No. 94374 A.

The Utica Drop Forge & Tool Company's Plant. Illustrated detailed description of plant and equipment for the manufacture of nippers and pliers. 2500 w. Ir Age—Aug. 6, 1908. No. 94179.

Tapping Machines.

Machines for Tapping Pipe Fittings. The machines are entirely automatic after the work is placed. Ills. 800 w. Am Mach—Vol. 31. No. 35. No. 94627.

Tempering.

Local Hardening and Tempering. William A. Painter. Describes the manipulations of tool steel by the flexible cover or shield method. Ills. 3300 w. Mach, N Y—Aug., 1908. No. 94114 C.

Welding.

Welding by Means of the Electric Arc. C. B. Auel. Describes the Zerener process, and the Benardos process. Ills. 2500 w. Am Mach—Vol. 31. No. 35. No. 94626.

Autogenous Welding and Metal Cutting (Die autogene Schweissung und das autogene Schneiden). August Bauschlicher. Describes the methods and results of using the oxy-acetylene and oxy-hydrogen blowpipes, giving costs. Ills. Serial. 1st part. 4400 w. Zeitschr f Werkzeug—July 25, 1908. No. 94574 D.

Wood-Working Machinery.

Wood-Working Machinery for Carriage and Wagon Building. Illustrated description of recent types of machines for preparing the woodwork of rolling-stock. 1200 w. Engng—July 31, 1908. No. 94266 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Britannia-Metal and How It Is Made. Information concerning the composition and use of this metal. 1000 w. Brass Wld—Aug., 1908. No. 94387.

About Some Characteristics of Magnalium. M. R. Machol. Information concerning this aluminum alloy. 2000 w. Automobile—Aug. 20, 1908. No. 94413.

Silicides for Containers of Acids. From a paper by Ad. Jouvé, before the Faraday Soc., on new applications of electro-metallurgical alloys. Briefly considers the manufacture of apparatus, the resistance to acids and other reagents. 1000 w. Elec-Chem & Met Ind—Aug., 1908. No. 94122 C.

Recent Researches on Copper-Alumini-

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um Alloys (Recherches Récentes sur les Alliages de Cuivre-Aluminium). L. Guillet. A general review of results. Ills. 4500 w. Rev de Métal—July, 1908. No. 94512 E + F.

Alloy Steels.

Special Steels for Electrical Purposes. Gives data in regard to steel for electrical machinery. 800 w. Elec Wld—Aug. 8, 1908. No. 94209.

Brass Refuse.

The Treatment of Ashes, Skimmings, Sweeps, Slags and Other Refuse by the Brass Rolling Mills in the United States. Erwin S. Sperry. Deals with methods of smelting brass refuse and other copper-bearing material. Ills. 1500 w. Brass Wld—Aug., 1908. No. 94385.

Metallography.

Micro-Structure of Foundry Irons. George Hailstone. Read before the Staffordshire Iron & Steel Inst. Discusses the action of the metalloids on the microstructure of iron. Ills. 4000 w. Foundry—Aug., 1908. No. 94190.

Constitution of Iron and Phosphorus Compounds. B. Saklatwalla. A complete thermal and metallographic investigation of the subject. Ills. 4000 w. Jour Ir & St Inst—No. II, 1908. No. 94612 N.

Iron, Carbon, and Sulphur. Donald M. Levy. Reports a research made to investigate the action of sulphur, as it affected the relations of iron and carbon. Ills. 16500 w. Jour Ir & St Inst—No. II, 1908. No. 94611 N.

The Microscopic Features of Hardened Supersaturated Steels. Edward Hess. States the object and method of investigation described, stating conclusions. Ills. 1200 w. Jour Ir & St Inst—No. II, 1908. No. 94609 N.

Hardness of the Constituents of Iron and Steel. H. C. Boynton. Compares the hardness of the constituents with Mohs scale for the hardness of minerals, reports tests and conclusions. Ills. 5400 w. Jour Ir & St Inst—No. II, 1908. No. 94614 N.

Experimental Researches on the Cooling Power of Liquids, on Quenching Velocities, and on the Constituents Troostite and Austenite. Carl Benedicks. Ills. 27600 w. Jour Ir & St Inst—No. II, 1908. No. 94615 N.

The Specific Heat of Iron (Die spezifische Wärme des Eisens). P. Oberhoffer. Describes method and devices for its determination and gives results of a large number of tests. Ills. 3300 w. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94653 D.

Packings.

The Development of Non-Metallic Packings. W. E. Sanders. A review of early forms of packing, giving classification, and stating objections to monkey-wrench packings. Ills. 2500 w. Power—Aug. 25, 1908. No. 94602.

Shaft Packing (Abdichtung von rotierenden Wellen). Leo Russmann. Describes recent developments in packing and stuffing boxes, particularly for steam turbines. Ills. Serial. 1st part. 1600 w. Elektrotech u Maschinenbau—July 26, 1908. No. 94595 D.

Steel.

Influence of Heat Treatment on Steel. Thomas J. Fay. Shows the various ways the grades of steel used in automobile work may be rendered best fitted. 4500 w. Automobile—Aug. 20, 1908. No. 94412.

See also Wire, under MATERIALS OF CONSTRUCTION.

Tool Steels.

The Manufacture of High-Speed Steel. O. M. Becker. Illustrates and describes workshop processes in the making of modern tool steels. 2500 w. Cassier's Mag—Aug., 1908. No. 94172 B.

Function of Chromium and Tungsten in High-Speed Tool Steel. C. A. Edwards. Report of an investigation, with conclusions. Ills. 7000 w. Jour Ir & St Inst—No. II, 1908. No. 94613 N.

Wire.

Investigations of the Flexibility of Wires (Untersuchung der Biegbarkeit von Drähten). Adolph Schuchart. Methods and results of tests of steel wires of various sizes and composition and subjected to various heat treatments. Ills. Serial. 1st part. 2400 w. Stahl u Eisen—July 1, 1908. No. 94551 D.

MEASUREMENT.

Dynamometers.

Barr and Stroud's Dynamometer. Diagrams and description of an electrical appliance for ascertaining the power transmitted by a revolving shaft. 3500 w. Mech Engr—Aug. 7, 1908. No. 94363 A.

Gauges.

A Measuring Machine of Simple Construction. Oscar E. Perrigo. Illustrates and describes a work gauging machine. 1800 w. Am Mach—Vol. 31. No. 34. No. 94408.

Pressure Gauges.

Gages for Measuring Pressures of Liquids. Franklin van Winkle. Describes the essential features of different types. Ills. 2500 w. Power—Aug. 18, 1908. No. 94381.

Scleroscope.

The Shore Scleroscope. J. F. Springer. Illustrated detailed description of an instrument for the measurement of hardness, and some of its applications. 2800 w. Ir Age—Aug. 27, 1908. No. 94623.

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Test Indicator.

A Test Indicator and Some of Its Applications. An instrument for setting and testing lathe, miller, shaper and surface plate work is illustrated and described. 900 w. Am Mach—Vol. 31. No. 35. No. 94630.

Testing Materials.

The Characteristics of Materials in Rupture Tests and in Flexure and Impact Tests on Nicked Bars (Ueber Materialeigenschaften im Zerreiss-, Kerbreiss-, und Kerbschlagversuche). O. Thallner. An experimental study of the accuracy of these methods. Ills. Serial. 1st part. 3000 w. Stahl u Eisen—July 29, 1908. No. 94557 D.

POWER AND TRANSMISSION.

Air Compressors.

The Design of Air Compressor Valves. States the conditions for good working of an air compressor, and the various types of valves. Ills. 2000 w. Mech Wld—Aug. 7, 1908. No. 94365 A.

New Norwalk Compressors and Unloading Devices. Illustrated detailed description of two new types of unloaders, explaining their advantages. 2000 w. Ir Age—Aug. 13, 1908. No. 94309.

Steam Consumption of Air Compressors. W. A. Macleod and J. P. Wood. From *Pro. Aust. Inst. of Min Engrs.* A report of tests, with an outline of the type and guarantee of the machines tested 1400 w. Aust Min Stand—July 8, 1908. Serial. 1st part. No. 94361 B.

See also Turbines, under STEAM ENGINEERING.

Belts.

The Modern Lenix System of Transmission (Transmissioni moderne Lenix). W. Zuppinger. Description and discussion of this system for keeping belts at proper tension. Ills. Serial. 1st part. 1200 w. Industria—July 12, 1908. No. 94542 D.

Compressed Air.

An Air Receiver and Pipe Line Explosion. S. A. Newton. An illustrated account of a disastrous accident to a compressed air system. 1000 w. Power—Aug. 25, 1908. No. 94600.

Costs.

Operating Results of the McKees Rocks Power Plant of the Pittsburg & Lake Erie Railroad. Explains briefly the operating organization and system of accounting, giving a study of results. 2500 w. Eng Rec—Aug. 22, 1908. No. 94494.

Electric Driving.

Electric Motor Printing Press Drive. S. H. Sharpsteen. Describes different methods. 2200 w. Elec Wld—Aug. 8, 1908. No. 94208.

Electrical Machinery in a Great Corn Products Plant. Illustrated description of the electrical equipment of a large factory at Roby, Ind. 2500 w. Elec Rev, N Y—Aug. 1, 1908. No. 94105.

See also Textile Mills, under POWER AND TRANSMISSION.

Lubricants.

The Engineer and Oil Analysis. Editorial aiming to show where the service of the oil analyst may be usefully engaged, and where dispensed with in the field of marine engineering. 1500 w. Engng—July 31, 1908. No. 94271 A.

Power Plants.

Modern Gas Engines vs. Steam Turbines in Mining. Frank C. Perkins. Reports tests made with turbine, gas, steam, and alcohol engines to ascertain their efficiency. Ills. 1700 w. Min Wld—Aug. 22, 1908. No. 94495.

Power System of the Henry Vogt Machine Co. Osborne Monnett. Illustrated description of an up-to-date steam-electric plant in Louisville, Ky. 2500 w. Power—Aug. 18, 1908. No. 94376.

The New Gas-Electric Power Plant at Gary, Ind. Claude Aikens. Description of engines in what is to be the largest power station in the world. Ills. 2500 w. Power—Aug. 18, 1908. No. 94379.

Power Plant of the New Union Terminal Station at Washington, D. C. Illustrated description of this terminal power plant, which supplies electricity for light and power, steam for the heating, compressed air for signal operation, hydraulic pressure for elevators, and refrigeration. 5000 w. Eng Rec—Aug. 8, 1908. No. 94231.

The Choice of Power for the Factory of Small or Medium Size (La Forza motrice nelle Officine di Piccola e Media Potenza). Salvatone Spera. A discussion of the relative economy of steam, gas, water and electric power. Serial. 1st part. 2500 w. Il Monit Tech—July 20, 1907. No. 94543 D.

Textile Mills.

Some Aspects of the Power Problems for the Textile Industries. Charles J. Kavanagh. An illustrated article considering the relative advantages of steam, gas, and electricity. 2200 w. Cassier's Mag—Aug., 1908. No. 94177 B.

STEAM ENGINEERING.

Boiler Design.

Boiler Headers and Connections. H. J. Ott. The design and the difficulties are briefly considered. Ills. 1500 w. Power—Aug. 11, 1908. No. 94278.

Boiler Explosions.

The Most Frequent Cause of Boiler Explosions. William H. Boehm. Explains how serious is scale in boilers. 900 w. Am Mach—Vol. 31. No. 32. No. 94183.

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Boiler Furnaces.

Pin Hole Grate Firing. Warren H. Miller. Describes this system and its operation, giving costs. 2000 w. Power—Aug. 18, 1908. No. 94377.

Boiler Inspection.

Necessity for Uniform Laws Covering the Construction and Inspection of Boilers. H. J. Hartley. Read before the Am. Boiler Mfrs. Assn. Ills. 3000 w. Boiler Maker—Aug., 1908. No. 94133.

Boiler Management.

Boiler Management in the Central Station (Du Contrôle de la Chauffe dans les Stations Centrales). J. Izart. A practical discussion. Ills. Serial. 1st part. 2000 w. L'Elecn—July 4, 1908. No. 94522 D.

Boiler Scale.

See Boiler Explosions, under MACHINE WORKS AND FOUNDRIES.

Boiler Theory.

The Law of Heat Transfer Through Steam Boiler Heating Surface. F. Kingsley. An examination of the theories advanced, giving results of tests. 1700 w. Eng Rec—Aug. 29, 1908. No. 94696.

Boiler Waters.

Experimental Electrical Treatment of Water to Remove Incrustating Solids. J. L. Campbell. Describes a plant, on the El Paso & S.-W. Ry. for softening water for locomotives. Ills. 1000 w. Eng News—Aug. 13, 1908. No. 94318.

Condensers.

The Modern Surface Condenser. George A. Orrok. An outline of recent progress in the development of condensers. 1200 w. Power—Aug. 11, 1908. No. 94276.

Cylinder Condensation.

Leakage and Condensation of Steam in Reciprocating Steam Engines. A report of experiments, stating conclusions. 4000 w. Engr, Lond—Aug. 14, 1908. No. 94479 A.

Engine Governors.

Inertia Governors (Sur les Regulateurs à Force d'Inertie tangentielle). M. Busset-Schiller. Describes and discusses mathematically recently developed types. Ills. 10500 w. Bul Soc Int d'Elecns—July, 1908. No. 94510 F.

Engine Lubrication.

See Superheating, under STEAM ENGINEERING.

Engine Reconstruction.

Increasing the Power of an Old Engine. Herbert L. Towle. Discusses in detail changes safe and unsafe in altering an old engine. Ills. 2500 w. Rudder—Aug., 1908. Serial, 1st part. No. 94186 C.

Feed-Water Heating.

The Feed-Water System for the Power Plant. Charles A. Howard. A summary of boiler-feed practice, discussing points in design, equipment, and operation. 3000 w. Engineering Magazine—Sept., 1908. No. 94682 B.

Fuels.

Coalesine Fuel: Utilization of House Refuse. Herbert Coales. A proposed method of converting refuse into fuel. Short discussion. 2200 w. Surveyor—Aug. 7, 1908. No. 94359 A.

The Nature of the Volatile Matter of Coal as Evolved Under Different Conditions. Horace C. Porter and F. K. Ovitz. Abstract of paper before the Am. Chem. Soc. describing investigations of the hydrocarbons given off at different temperatures. 2200 w. Elec Rev, N Y—Aug. 22, 1908. No. 94418.

Some Things a Power User Should Know About Coal. E. G. Bailey. Read at the Nat. Assn. of Cotton Mfrs., Boston. Discusses knowledge necessary for the continuous and economic operation of the plant. 3500 w. Can Engr—Aug. 7, 1908. No. 94239.

Fuel Testing.

Relation of Government Fuel Investigation to the Solution of the Smoke Problem. D. T. Randall. Statistics concerning the enormous amount of fuel consumed annually, and the efforts to correct wasteful methods. 1400 w. Cent Sta—Aug., 1908. No. 94288.

Plant Management.

The Present Status of Coal-Power. D. B. Waters. A lecture on the methods of utilizing coal-power, steam plants and their efficiency, etc. 4500 w. N Z Mines Rec—June 16, 1908. Serial, 1st part. No. 94622 B.

Superheating.

The Specific Heat of Superheated Steam. Gives reply of Doctors Jakob and Knoblauch to Prof. Reede's criticism; and Prof. Heck on Reeve's views of terminology and nature of entropy. 3000 w. Power—Aug. 4, 1908. No. 94130.

The Effect of Superheated Steam on Hydro-Carbon Cylinder Oils. G. W. Worrall. Abstract from *Jour. Soc. of Chem. Ind.* A report of experiments undertaken to gain information on the problem of cylinder lubrication. 1000 w. Engr, Lond—July 24, 1908. No. 94167 A.

The Theory of Superheated Steam Taking Account of the Variability of Its Specific Heat at Constant Pressure (Théorie de la Vapeur d'Eau surchauffée, tenant Compte de la Variabilité de sa Chaleur spécifique à Pression constante). M. Thonet. A theoretical discussion. Ills. 6000 w. Rev de Mécan—July, 1908. No. 94520 E + F.

Turbines.

The Application of Exhaust-Steam Turbines (Die Verwendung von Abdampfturbinen). Dr. A. Gradenwitz. A gen-

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eral description of the Rateau low-pressure turbine system. Ills. Serial, 1st part. 1700 w. Zeitschr f d Gesamte Turbinenwesen—July 30, 1908. No. 94572 D.

The Application of the Work Diagram to the Design of Steam Turbines and Compressors (Die Beurteilung der Dampfturbinen und Kompressoren auf Grund des Arbeitsdiagrammes). Guido Zerkowitz. A mathematical discussion. Ills. Serial, 1st part. 1600 w. Zeitschr f d Gesamte Turbinenwesen—July 20, 1908. No. 94571 D.

Valve Gears.

The Reynolds Long Range Cut-Off. Hubert E. Collins. Illustrates and describes the essential features of design and operation of this valve-gear as usually employed on the Allis-Chalmers engines of this type. 1500 w. Power—Aug. 11, 1908. No. 94277.

TRANSPORTING AND CONVEYING.

Coal Handling.

A Coaling Staith and Hoist on the Tyne. Illustrations, drawings, and brief description. 400 w. Engr, Lond—Aug. 14, 1908. No. 94482 A.

Inclined Retort Coal- and Coke-Handling Plant at Bristol. William Stagg. Describes in detail the plant for the mechanical handling of materials. Ills. 4000 w. Inst of Mech Engrs—July 28, 1908. No. 94260 N.

The Coal Industry of Greater New York. Werner Boecklin. Illustrates and describes the storage and machinery facilities for handling 30,000,000 tons annually. 2000 w. Engineering Magazine—Sept., 1908. No. 94683 B.

Mechanical Unloading, Loading and Storage Appliances for Materials in Bulk (Zur Frage der mechanischen Lösch-, Lade- und Lager-Vorrichtungen für Massengüter). M. Buhle. Describes new coal- and ore-handling installations in Europe. Ills. 2200 w. Glasers Ann—July 1, 1908. No. 94576 D.

Conveyors.

The Gibb Underground Conveyor. Illustrated description of this conveyor and its application to the working of thin seams. 3000 w. Col Guard—Aug. 7, 1908. No. 94369 A.

See also Cyaniding, under MINING AND METALLURGY, GOLD AND SILVER.

Cranes.

The Equipment of Electrical Cranes. R. H. Fenkhausen. Considers the choice and care of motors, hoists and brakes, and troubles liable to be encountered. 2000 w. Power—Aug. 4, 1908. No. 94126.

Elevators.

The High Pressure Hydraulic Elevator. William Baxter, Jr. Considers the adjustment and care of automatic stop valves and mechanism, and packings in the present number. Ills. 2500 w. Power—Aug. 18, 1908. Serial, 1st part. No. 94380.

High Speed Elevators. W. W. Lighthipe. Gives statistics showing that twice as many people are carried vertically as are carried horizontally in New York City every 24 hours, and describes the types of high-speed elevators used. 2000 w. Sch of Mines Qr—July, 1908. No. 94285 D.

Materials Handling.

Hoisting and Handling Machinery in Steel Works and Rolling Mills (Hebe- und Transportmittel in Stahl- und Walzwerksbetrieben). G. Stauber. Illustrated description of many types. Serial, 1st part. 1500 w. Stahl u Eisen—July 15, 1908. No. 94554 D.

MISCELLANY.

Aeronautics.

Advance in Aeronautical Motor Building. W. F. Bradley. An illustrated article considering the new principles in aero engine design. 3000 w. Automobile—Aug. 13, 1908. No. 94335.

Recent Foreign Aeroplanes. Illustrates and describes recent types experimented with in France. 1200 w. Sci Am—Aug. 22, 1908. No. 94423.

Conditions of Success with Aeroplanes. L. J. Lesh. Suggestions, dealing exclusively with aeroplanes. 2500 w. Sci Am Sup—Aug. 8, 1908. No. 94226.

The Wright Brothers' Aeroplane in France and the United States. Photographs and description of the aeroplane and its operation. 1800 w. Sci Am—Aug. 29, 1908. No. 94639.

The Zeppelin Air-Ships. Describes the type of balloon advocated by this aeronaut and gives a brief review of what he has accomplished. 2500 w. Engng—July 31, 1908. No. 94265 A.

The Design of Recent Airships (Die neueren Luftschiffe, ihre Bauart und technischen Einrichtungen). Herr Buchholtz. A review of recent progress in design, means of propulsion, etc. Ills. 5500 w. Glasers Ann—July 1, 1908. No. 94575 D.

Practical Notes on the Construction of Air Ships (Erfahrungen beim Bau von Luftschiffen). Count Zeppelin. A general review of the problems encountered. 3800 w. Zeitschr d Ver Deutscher Ing—July 25, 1908. No. 94651 D.

Guns.

The 2.95-In. Deport Field-Gun at the Franco-British Exhibition. Illustrated description of the principal features and

dimensions. 2000 w. Engng—Aug. 7, 1908. No. 94372 A.

The Normal Automatic Gun, Sjogren System. Illustrates and describes a self-acting, recoil-operated shot-gun, fitted with a rigid non-recoiling barrel. 1000 w. Engng—July 24, 1908. No. 94160 A.

Gyroscopes.

I. The Gyroscope and How We May Make It Useful. Arthur Gordon Webster. Illustrates and describes its powers. II. Some Applications of the Gyroscope. J. F. Springer. In mono-railroads and ship steadying. Ills. 5000 w. Am Rev of Revs—Aug., 1908. No. 94282 C.

Match Machinery.

How Matches Are Made. O. Bechstein. Illustrates and describes the ingenious machinery used. 1800 w. Sci Am Sup—Aug. 29, 1908. No. 94641.

Sugar Plant.

Eleven-Roll Sugar-Cane-Crushing Plant. Illustrated description of a mill recently built for a plant in Brazil. 1200 w. Engng—Aug. 14, 1908. No. 94475 A.

Textile Machinery.

Safety Appliances on Cotton-Twiners. Illustrates and describes methods of guarding these machines. 2000 w. Engng—Aug. 7, 1908. No. 94371 A.

Watches.

The Mechanism of the Watch You Carry. W. H. Ebelhare. Illustrated detailed description of a watch movement. 4500 w. Am Mach—Vol. 31, No. 33. No. 94315.

MINING AND METALLURGY

COAL AND COKE.

Accidents.

Causes of Accidents in Mines and Their Prevention. D. J. Roderick. Especially considers causes in the Hazleton, Pa., coal fields, but reviews a number of disasters in the anthracite region. 3000 w. Ind Wld—Aug. 10, 1908. Serial, 1st part. No. 94244.

Bins.

See Tipples, under COAL AND COKE.

Blasting.

Shot Firing by Electricity. D. Harrington. Describes the method of firing all shots from the surface, as used by the Utah Fuel Co. Ills. 3000 w. Mines & Min—Aug., 1908. No. 94078 C.

Briquettes.

Briquetted Coal in Brooklyn. Clifford D. Meeker. Illustrated description of a coal briquetting plant in Brooklyn, its machinery and conveyor layout. 2800 w. Eng Rec—Aug. 15, 1908. No. 94342.

Coke Ovens.

A New System of Modern Coke Ovens. F. Fieschi. Gives details of construction and operation which permit saving by-products and excess gases. Ills. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94445.

New Coke Oven Installations by the Koppers Company. Explains the difference between retort ovens and beehive ovens and their working, and reviews the progress in both fields, giving illustrated description of the new system of Koppers, and stating its advantages. 6000 w. Ir & Coal Trds Rev—July 24, 1908. No. 94170 A.

Technical Criticism of the Coke Oven Industry (Kritische Streifzüge durch das technische Gebiet der Koksofenindustrie). C. Still. Application of Bernoulli's law to retort-oven construction. Mathematical. Ills. Serial, 1st part. 4000 w. Glückauf—July 4, 1908. No. 94563 D.

Electric Power.

The Electrical Equipment of the Ferndale Collieries, South Wales. Illustrated detailed description. 2500 w. Elec Rev, Lond—July 31, 1908. No. 94253 A.

See also Central Stations, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Explosions.

Preventing Mine Explosions. George H. Ashley. Gives a suggested method of working and ventilating. 3000 w. Mines & Min—Aug., 1908. No. 94075 C.

Mexico.

Coal Mines of Mexico. Manuel Schwarz. Gives the locations of the different coal basins, the extent of development and output. Ills. 1500 w. Mines & Min—Aug., 1908. No. 94077 C.

Mine Fires.

Report on the Hamstead Colliery Fire. Reviews the report of R. A. S. Redmayne on the causes of, and circumstances attending, the underground fire at this colliery near Birmingham, Eng. Ills. 7500 w. Col Guard—Aug. 14, 1908. No. 94469 A.

Mine Gases.

The Fight Against Fire Damp and Carbon Monoxide in Coal Mines (La Lutte contre le Grisou et contre l'Oxyde de Carbone dans les Mines de Houille). M. Gréhant. Describes the author's apparatus, and methods for gas analysis and testing. Ills. 3800 w. Bul Soc d'Encour—June, 1908. No. 94514 G.

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Mine Inspection.

Coal Mines Inspection in 1907. Digest of the reports of H. M. inspectors of mines. Ills. 60700 w. Col Guard (Sup.)—Aug. 7, 1908. No. 94368 A.

Mine Rules.

Rules of the H. C. Frick Coke Co. Gives rules required to be printed in the various languages spoken by the miners and posted at all the mines of the company. 1500 w. Mines & Min—Aug., 1908. No. 94074 C.

Mining.

Losses of Coal in Mining a Flat Seam. Audley H. Stow. Considers points of importance in securing economy of operation. 5000 w. Eng & Min Jour—Aug. 8, 1908. No. 94236.

Suggested Mining Method for Pittsburg Seam. R. Y. Williams. Presents a new plan, claiming greater safety and a 30 per cent. reduction of losses of coal. Ills. 2000 w. Eng & Min Jour—Aug. 15, 1908. No. 94351.

See also Conveyors, under MECHANICAL ENGINEERING, TRANSPORTING AND CONVEYING.

Peat.

The Utilization of Peat for Industrial and Metallurgical Purposes. E. Nystrom. Brief discussion of the conditions in Canada for the manufacture of peat fuel. 1400 w. Qr Bul of Can Min Inst—July, 1908. No. 94394 N.

Scotland.

The Coal Measures of the Carron and Slamannan District. The Falkirk area and the Greengairs district are described, and also the character of the deposits. 2500 w. Ir & Coal Trds Rev—Aug. 14, 1908. No. 94484 A.

Storage.

Some Experiments in the Storage of Coal. E. A. Fessenden and J. R. Wharton. Remarks on coal storage systems, with report of experimental investigations. 5000 w. Bul Univ of Missouri—No. 1. No. 94499 N.

Tipples.

Steel Tipples and Bins. W. R. Elliott Discusses causes of deterioration and precautions advisable in design to insure their preservation at bituminous coal mines. 2200 w. Mines & Min—Aug., 1908. No. 94070 C.

Washing.

Coal Washing (Le Lavage des Charbons). H.-A. Henry. A theoretical discussion of principles and a description of a system of hydraulic control and operation of the various machines used. Ills. 7000 w. All Indus—July, 1908. No. 94525 D.

Modern Coal Washing and Iron-Ore Dressing (Ueber moderne Aufbereitung von Kohle und Erzen). E. Ruland-Klein. The first part describes new devices for screening and washing coal. Ills. Serial, 1st part. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 25, 1908. No. 94562 D.

COPPER.

Alaska.

The Copper Deposits of Kasaan Peninsula, Alaska. Charles W. Wright. Map, with description of the geology, ore deposits, etc. 2200 w. Ec-Geol—July, 1908. No. 94301 D.

Blast-Furnace Slag.

Alumina in Copper Blast-Furnace Slags. Charles F. Shelby. A study of a variety of slags with evidence to show that alumina acts as an acid combining with more basic oxides. 7000 w. Eng & Min Jour—Aug. 8, 1908. No. 94234.

British Columbia.

The "White Bear Mine," Rossland, B. C. H. H. Yuill. Illustrations, drawings and description. 3500 w. Qr Bul of Can Min Inst—July, 1908. No. 94400 N.

Granby Mining Methods. C. M. Campbell. Illustrates and describes methods aiming at a large daily tonnage. 4000 w. Qr Bul of Can Min Inst—July, 1908. No. 94399 N.

California.

See Ore Deposits, under MISCELLANY.

Cornwall, Eng.

Geological Aspect of the Lodes of Cornwall. Donald A. MacAlister. A general geological description is given, the tin and copper districts, lode structures, genesis of the ores, etc. Map. 5000 w. Ec-Geol—July, 1908. No. 94299 D.

Electro-Metallurgy.

The Direct Production of Copper Tubes, Sheets, and Wire. Sherard O. Cowper-Coles. Describes methods of direct production by electrolysis from impure copper. Ills. 3500 w. Inst of Mech Engrs—July 28, 1908. No. 94261 N.

Mexico.

Prospecting for Copper in Southern Michoacan, Mexico (Prospection pour Cuivre au Sud de l'Etat de Michoacan, Mexique). Raoul Bigot. A description of the ores and prospects of the district. Ills. 11000 w. Mem Soc Ing Civ de France—May, 1908. No. 94506 G.

Nevada.

Mining and Reduction of Ely Ores. R. L. Herrick. Gives the location of this Nevada camp, describing the copper ores, geological conditions, and methods of mining. Ills. 4500 w. Mines & Min—Aug., 1908. Serial, 1st part. No. 94076 C.

Smelter Smoke.

Cottrell Process for Condensing Smelter Fumes. Describes the apparatus em-

ployed and the principles involved in this electrostatic system. 3000 w. Eng & Min Jour—Aug. 22, 1908. No. 94444.

GOLD AND SILVER.

Cobalt.

Wanted—A Capitalization Basis for Cobalt Companies. Alexander Gray. Discusses the financing of Cobalt flotations. 3500 w. Min Jour—Aug. 1, 1908. No. 94256 A.

The Nipissing Mines and Their Numerous Veins. Alex. Gray. Information concerning these silver mines, the production costs and profits, and problems. 3500 w. Min Wld—Aug. 22, 1908. No. 94497.

Property and Prospects of La Rose Mines, Cobalt. Alex. Gray. Information concerning the geology and development; ore shipments and recovery of silver, cobalt, nickel, and arsenic during the past four years. 4000 w. Min Wld—Aug. 15, 1908. No. 94355.

Methods of Concentration at Cobalt, Ontario. George E. Sancton. An outline of the manner in which the ores are concentrated in the three mills which are now working, and of the proposed method of treatment at the Muggley concentrator. 3000 w. Qr Bul of Can Min Inst —July, 1908. No. 94398 N.

Cyaniding.

Cyanidation in Mexico. Francis J. Hobson. A report of experience, considering the adaptability of the cyanide process for the extraction of silver from its ores. 2000 w. Min & Sci Pr—Aug. 1, 1908. Serial, 1st part. No. 94202.

Cyanide Sand Handling at the Robinson Mine. Albert F. Crank. Extracts from a paper read before the S. African Assn. of Engrs. Illustrates and describes the automatic handling machinery and its working. 2800 w. Min Jour—July 25, 1908. No. 94156 A.

Dredging.

Dredge Working in Severe Cold. E. N. Barbot de Marny. Gives experience and opinion in Russia. 2500 w. Min Jour—Aug. 1, 1908. No. 94258 A.

Recent Developments in Gold Dredging. Frank W. Griffin. An illustrated review of progress. 2500 w. Min & Sci Pr—Aug. 15, 1908. No. 94415.

History.

Gold: Its History and Economic Development. Evans W. Buskett. Its properties, occurrence, etc. 2000 w. Min Wld —Aug. 1, 1908. Serial, 1st part. No. 94094.

India.

The Auriferous Deposits of India. Dr. Malcolm Maclaren. Reviews the history of gold mining in India, and describes the geology of the auriferous areas, in the present number. 3000 w. Min Jour —Aug. 15, 1908. Serial, 1st part. No. 94467 A.

Mexico.

Mining Camp of Topia, State of Durango, Mex. T. C. Graham. Gives the history and development of this silver-lead district. Ills. 1400 w. Min Wld—Aug. 1, 1908. No. 94091.

The Silver-Lead Mines of Santa Barbara, Mexico. Claude T. Rice. An illustrated article giving the history and geology of the district, the character of the ores and their treatment. 3000 w. Eng & Min Jour—Aug. 1, 1908. No. 94081.

Mines of Penoles Company, Mapimi, Mex. Claude T. Rice. Brief review of the history of these old silver-lead mines, and the modern methods of mining. The ore occurs in chimneys and pipes in limestone. Ills. 4500 w. Eng & Min Jour —Aug. 15, 1908. Serial, 1st part. No. 94347.

Geology of the Mining Districts of Chihuahua, Mexico. Rufus M. Bagg, Jr. Illustrates and describes this gold-bearing region and its development. 1500 w. Min & Sci Pr—Aug. 1, 1908. Serial, 1st part. No. 94200.

The Silicious Silver Mines of Parral, Mexico. Claude T. Rice. Gives the history and geology of the district, account of the mines, etc. Ills. 3300 w. Eng & Min Jour—Aug. 8, 1908. No. 94235.

New Zealand.

Te Coromandel Goldfield. Colin Fraser and James Henry Adams. Description and history of gold-mining in this district. 5000 w. N Z Mines Rec—June 16, 1908. No. 94620 B.

Gold-Deposits in Central Otago. From a Bulletin by Prof. James Park. The present number treats of some principles of concentration in river-bed gravels. 2000 w. N Z Mines Rec—June 16, 1908. Serial, 1st part. No. 94621 B.

The Great Waihi Mine. J. M. Bell. Describes the general geology, the principal veins, and the vein material in the present number. Ills. 4000 w. Can Min Jour—Aug. 15, 1908. Serial, 1st part. No. 94433.

Oregon.

Notes on Southern Oregon as Prospecting Field. Dennis H. Stovall. Information concerning conditions, geology, and peculiar occurrence of gold. 1000 w. Min Wld—Aug. 1, 1908. No. 94093.

Placers.

Some Principles of Concentration in River-Bed Gravels. James Park. Considers the progress of river erosion, the river bed bottom, position of pay wash,

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etc. 2500 w. Min Jour—Aug. 1, 1908. No. 94257 A.

Quebec.

Gold in the Eastern Townships of the Province of Quebec. J. Obalski. Notes on the distribution, and discoveries made. Map. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94395 N.

Rand.

New Mining and Milling Practice on the Rand. Eustace M. Weston. Recent improvements in efficiency and reduced cost. 2000 w. Eng & Min Jour—Aug. 15, 1908. No. 94349.

Some Striking Features of Rand Gold Production. Ralph Stokes. Considers factors that have influenced mining and milling. Thinks the Robinson will prove the greatest gold mine in the world. Ills. 1000 w. Min Wld—Aug. 1, 1908. No. 94092.

Silver.

Silver. Theo. F. van Wagenen. Interesting information in regard to its production, value, etc. 4500 w. Pop Sci M—Sept., 1908. No. 94618 C.

Silver Refining.

Refining of Silver Bullion Containing Arsenic and Antimony. B. Neilly. Students' competition paper. An account of experimental investigations. Ills. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94402 N.

Yukon.

Mining and Mining Methods of the Yukon. A. A. Paré. Notes on the placer and gravel mining methods, with sketches of the geology and other details. Ills. 6500 w. Qr Bul of Can Min Inst—July, 1908. No. 94401 N.

IRON AND STEEL.

Alabama.

Gray Hematites of Eastern Alabama. Edwin C. Eckel. Information concerning this new ore field. 3000 w. Ir Trd Rev—Aug. 6, 1908. No. 94193.

Assaying.

The Determination of Tungsten in Steel in the Presence of Chromium (Ueber die Bestimmung von Wolfram im Stahl bei Gegenwart von Chrom). G. v. Knorre. A review of recent literature. 2700 w. Stahl u Eisen—July 8, 1908. No. 94553 D.

Blast-Furnace Charging.

Electrical Operation of Blast-Furnace Charging Devices (Die elektrischen Betriebsmittel für die Hochofenbeschickung). C. Schiebeler. Discusses electrical operation and describes apparatus used. Ills. 3000 w. Stahl u Eisen—July 8, 1908. No. 94552 D.

Blast Furnaces.

The New Vanderbilt Furnace of the Birmingham Coal & Iron Co. Illustrated description of a southern furnace fitted with a revolving distributor, auxiliary dust catchers, and many devices looking to economical operation. 2200 w. Ir Trd Rev—Aug. 6, 1908. No. 94194.

Bombshell Ore.

The Origin of Bombshell Ore. H. M. Chance. Describes the ore to which this term is applied and gives a theory to account for its origin. 1800 w. Can Min Jour—Aug. 15, 1908. No. 94434.

Electro-Metallurgy.

Experimental Electric Smelting. Louis D. Farnsworth. An illustrated report of experiments made to learn some of the fundamental principles of electric smelting and to obtain data of their working. 1200 w. Elec-Chem & Met Ind—Aug., 1908. No. 94123 C.

Progress in the Electric Iron and Steel and Ferro-Alloys Industries. John B. C. Kershaw. Information concerning progress in the electric furnace methods of manufacture. Ills. 3300 w. Elect'n, Lond—Aug. 7, 1908. No. 94367 A.

Treatment of Iron and Steel in the Electric Furnace. Ernesto Stassano. Gives a report of results regularly obtained, with illustrated descriptions of electric furnaces used at Stassano Steel Works, Turin, Italy. 4000 w. Elec-Chem & Met Ind—Aug., 1908. No. 94121 C.

The Desulphurization of Ingot-Iron in the Electric Induction Furnace (Die Entschwefelung des Flusseisens im elektrischen Induktionsofen). Bernhard Osann. Gives results of tests. 3000 w. Stahl u Eisen—July 15, 1908. No. 94555 D.

England.

The Hematite Mines of Cumberland, England. Lucius W. Mayer. The caving system is employed with varying methods for removing the pillars and supporting the ground. Ills. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94440.

Ferro-Alloys.

Formation and Properties of Electrically Produced Ferro-Alloys (Zusammensetzung und Eigenschaften von auf elektrischem Wege darstellbaren Eisen-Legierungen). A review of recent progress. Serial, 1st part. 1200 w. Elektrochem Zeitschr—July, 1908. No. 94549 D.

France.

The Iron Industry of the World and the Exploitation of the Briey Basin (Le Minerai de Fer dans le Monde et la Mise en Valeur du Bassin de Briey). A. Couroux. Concerned chiefly with the iron ore supplies of France, and particularly the Briey deposits. 12500 w. Mem Soc Ing Civ de France—May, 1908. No. 94503 G.

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Open Hearth.

See Gas Producers, under MECHANICAL ENGINEERING, COMBUSTION MOTORS.

Pig Boiling.

Iron Scrap or the Issue of an Old Shoe Heel, Being the Origin of the Discovery of Pig Boiling. Joseph Hall. Reprint of a pamphlet published in London in 1864. 4400 w. Jour Ir & St Inst—No. II, 1908. No. 94617 N.

Refining.

Preliminary Results of Trials in Refining Iron and Steel by Means of Vapors of Metallic Sodium. Albert Hiorth. Describes methods and apparatus used and results obtained. Secretary's note given. 2500 w. Jour Ir & St Inst—No. II. 1908. No. 94616 N.

Rolling Mills.

The Inland Steel Company's New Morgan Merchant Mill. Illustrated description of a mill of the semi-continuous type. 1500 w. Ir Age—Aug. 27, 1908. No. 94625.

Sheets.

The Etching of Thin Plates (Das Beizen der Feinbleche). B. Clement. A description of methods and machines for dipping plates preparatory to surface treatment for the production of zinc, lead, tin, or other deposit. Ills. 4000 w. Stahl u Eisen—July 1, 1908. No. 94550 D.

Steel Making.

Tool Steel Making in Styria. R. F. Böhler. An account of this industry in the Styrian Alps, Austria, outlining its history. 3300 w. Sch of Mines Qr—July, 1908. No. 94286 D.

Steel Works.

New Works of the Whitehead Iron and Steel Company, Limited, Tredegar, Mont. Outlines the history of this industry, and illustrates and describes the improved plant. 5000 w. Ir & Coal Trds Rev—Aug. 14, 1908. No. 94483 A.

LEAD AND ZINC.

Great Britain.

Zinc-Mining in Great Britain. Editorial, considering briefly the condition of the industry and the principal mining districts. 2500 w. Engng—July 24, 1908. No. 94161 A.

Lead Pigments.

Making a Zinc-Lead White at Canyon City. Illustrates and describes how the U. S. Smelting Co. utilizes zinc-lead ores, after concentration, for making a high-grade pigment. 1500 w. Min Wld—Aug. 1, 1908. No. 94095.

Lead Smelting.

Zinc and Lead Smelting in Silesia. J. S. G. Primrose. Illustrated description of methods used. 3300 w. Eng & Min Jour—Aug. 8, 1908. No. 94233.

The Cost of Silver-Lead Smelting. Walter Renton Ingalls. A study of the American Smelting and Refining Company, which is estimated to have made a profit of $2 per ton of ore smelted. 8500 w. Eng & Min Jour—Aug. 15, 1908. No. 94348.

See also Zinc Smelting, under LEAD AND ZINC.

Mexico.

Treatment Locally of the Ores of Topia, Mexico. T. C. Graham. Outline of the practice of crushing and milling (by lixiviation). 1000 w. Min Wld—Aug. 22, 1908. No. 94496.

See also same title, under GOLD AND SILVER.

Missouri.

See Plants, under MINING.

New Mexico.

The Ore Deposits of Magdalena, New Mexico. Philip Argall. An illustrated description of the geology, the deposits of lead-carbonates, zinc-carbonates, mixed iron oxide, zinc blende, and pyrite, etc. 4500 w. Eng & Min Jour—Aug. 22, 1908. No. 94442.

Zinc Smelting.

Modern Developments in the Metallurgy of Lead and Zinc. A. Selwyn-Brown. Considers the treatment of low-grade ores, showing that it also leads to the recovery of gold and silver. Ills. 3500 w. Engineering Magazine—Sept., 1908. No. 94679 B.

See also Lead Smelting, under LEAD AND ZINC.

MINOR MINERALS.

Antimony.

The Herrenschmidt's Process of Antimony Smelting. C. Y. Wang. Describes the apparatus and process, and gives results of experiments. Ills. 1200 w. Min Jour—July 25, 1908. No. 94155 A.

Cement.

Some British Cement Plants. A general illustrated description of three large works. 1500 w. Eng Rec—Aug. 29, 1908. No. 94690.

Limestone Island, Whangarei Harbor. Alex. Kyle. A short description of this island of New Zealand and the works of the N. Z. Portland Cement Co. 1000 w. N Z Mines Rec—May 16, 1908. No. 94-138 B.

A Great Cement Plant in Tennessee. Wm. H. Stone. Illustrated detailed description of plant at Richard City. 3500 w. Mfrs Rec—Aug. 20, 1908. No. 94409.

See also Hydro-Electric, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Graphite.

A Contribution to the Discussion on

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the Genesis of Graphite in Argenteuil and Labelle Counties, in the Province of Quebec. F. Hille. Discussion of paper by H. P. H. Brumel. 2700 w. Can Min Jour—Aug. 1, 1908. No. 94132.

Gypsum.

Gypsum Plant in Southwest Virginia. William H. Stone. Illustrated description of mine and plant. 1500 w. Mfrs Rec—Aug. 20, 1908. No. 94410.

Nickel.

Electrodeposition of Nickel. Edward F. Kern and Francis G. Fabian. Based on investigations. 10000 w. Sch of Mines Qr—July, 1908. No. 94287 D.

Oil.

The Petroleum and Manjak Industry of Barbados. Edmund Otis Hovey. Describes the oil deposits and their development. 2200 w. Min Wld—Aug. 15, 1908. No. 94356.

The Quest for Oil in the Poverty Bay District. William E. Akroyd. Gives details of what has been done toward developing this district of New Zealand. 3300 w. N Z Mines Rec—May 16, 1908. No. 94137 B.

Platinum.

The Platinum Situation. Trans. from *Torgovo Promysshlennaya Gazeta*. Discusses the position of Russia. 3000 w. Min Jour—July 25, 1908. No. 94157 A.

Tin.

Mining Lode Tin in Malaya. Describes the deposits and methods of tin mining. 2000 w. Eng & Min Jour—Aug. 22, 1908. No. 94443.

Progress and Developments in the Metallurgy of Tin, with Special Reference to Electro-Chemistry in 1907 (Fortschritte und Neuerungen in der Metallurgie des Zinns, speziell in Elektrochemischer Hinsicht im Jahre 1907). Dr. H. Mennicke. Serial, 1st part. 1800 w. Electrochem Zeitschr—July, 1908. No. 94548 D.

See also Cornwall, Eng., under COPPER.

MINING.

Balances.

Balances. A. Austin and Swift Hunter. A discussion of laboratory balances, their care and operation. 2500 w. Min & Sci Pr—Aug. 15, 1908. No. 94416.

Drilling.

Prospect Drilling in the Joplin District. Otto Kuhl. Discusses the difficulties encountered and cost. Ills. 2500 w. Mines & Min—Aug., 1908. No. 94071 C.

Steam Churn Drill in Hot and Cold Climates. John Power Hutchins. Explains the difficulties and causes of expense, describing the equipment best suited to the regions. Ills. 2200 w. Eng & Min Jour—Aug. 1, 1908. No. 94083.

Drills.

Report of a Committee on Rock Drill Tests Conducted at the Meyer & Charlton G. M. Co., Ltd., and a Discussion of Some Special Observations. Paper by E. J. Laschinger, with committee report. 10000 w. Jour S African Assn of Engrs —June, 1908. No. 94141 F.

Education.

See same title, under INDUSTRIAL ECONOMY.

Electric Power.

Electric Power at the Mines of the Ilse Mining Company (Der elektrische Kraftbetrieb auf den Werken der Bergbau-Akt.-Ges. Ilse). W. Bolz. Illlustrated description of extensive installations. Serial, 1st part. 1600 w. Elek Kraft u Bahnen—July 24, 1908. No. 94591 D.

Applications of Electric Power in the Clausthal District (Die Anwendung elektrischer Triebkraft in den Betrieben der kgl. Berginspektion zu Clausthal). Herr Schennen. Describes applications to hoisting, ore dressing plants, etc. Ills. 4000 w. Elek Kraft u Bahnen—July 14, 1908. No. 94590 D.

Geological Surveys.

Topographical Methods Used for the Special Map of Rossland, B. C. W. H. Boyd. Describes methods used, giving maps. 4000 w. Qr Bul of Can Min Inst —July, 1908. No. 94392 N.

Haulage.

Comparison of Horse and Benzine-Locomotive Haulage (Vergleich einer Pferde- und Benzinlokomotivförderung am Michael-Schachte der Kaiser Ferdinands-Nordbahn in Michalkowitz). Franz Steller. A comparison of costs from actual operation. 3000 w. Oest Zeitschr f Berg- u Hüttenwesen—July 25, 1908. No. 94561 D.

See also Track Laying, under MINING.

Law.

The St. Louis-Montana Co.'s Apex Litigation. Matt W. Alderson. An explanation of a peculiar case in which a 30-ft. strip has been granted the usual apex right and a vertical right, also. 2000 w. Min Wld—Aug. 8, 1908. No. 94245.

Plants.

Power Systems of the Mines of the Joplin District. D. F. Boardman. The types in use are described; the gas engine plant showing the greatest economy. 3000 w. Eng & Min Jour—Aug. 15, 1908. No. 94350.

See also Power Plants, under MECHANICAL ENGINEERING, POWER AND TRANSMISSION.

Pumping.

Pumping Problems of the Joplin Dis-

trict. Doss Brittain. Explains the conditions and the difficulties of keeping the workings free from water. Ills. 3500 w. Eng & Min Jour—Aug. 1, 1908. No. 94082.

Shaft Sinking.

Shaft Sinking by Cementation. L. Morin. Abstract translation from *Ann. des Mines.* Illustrated description of the method adopted at the Lievin collieries. 1800 w. Eng & Min Jour—Aug. 1, 1908. No. 94084.

Stoping.

Back-Stoping vs. Underhand Stoping in Large Bodies of Iron Pyrites. J. J. Rutledge. Considers the conditions which led to the adoption of the underhand method. 1000 w. Eng & Min Jour—Aug. 22, 1908. No. 94441.

Surveying Instruments.

The Gebrüder Rost, Vienna, Universal Support and Mining Transit (Universal-Grubenspreize und Zentrierapparat der Gebrüder Rost in Wien). E. Dolezal. Illustrated description of a transit carried on an extensible shaft and capable of being set in any position, for use in mine gallieries and stopes. Serial, 1st part. 2200 w. Oest Zeitschr f Berg- u Hüttenwesen—July 4, 1908. No. 94559 D.

Track Laying.

A Discussion of Mine Curve Problems. J. E. Tiffany. Gives approved methods of alinement. 3500 w. Eng & Min Jour—Aug. 1, 1908. No. 94085.

Valuation.

Calculating the Value of a Mine. J. Bowie Wilson. Describes the practice at Mount Morgan G. M. Co. (Q.). 2500 w. Aust Min Stand—July 8, 1908. Serial, 1st part. No. 94362 B.

ORE DRESSING AND CONCENTRATION.

Drying.

The Thermal Principles of Industrial Drying (Fonctionnement Thermique du Séchage industriel). Paul Razous. Discusses and gives formulæ relating to the drying of materials by evaporation. 3000 w. Rev d'Econ Indus—July 16, 1908. No. 94500 D.

Filters.

Continuous Slime Filter. Robert Schorr. Illustrated description of an invention of the writer. 800 w. Min & Sci Pr—Aug. 8, 1908. No. 94331.

Gold Milling.

Milling Practice in Nevada Goldfield Reduction Works. E. S. Leaver. Describes practice at a custom plant, ores being received from various mines. 500 w. Min & Sci Pr—Aug. 22, 1908. No. 94646.

Yellow Jacket Mill, Comstock Lode. Whitman Symmes. Illustrated description of methods of milling low-grade ore. 1200 w. Min & Sci Pr—Aug. 1, 1908. No. 94201.

Iron Ores.

See Washing, under COAL AND COKE.

Silver Milling.

Inexpensive Home-Made 20-Ton Mill. Teodoro Köhncke. Describes a mill built in Central America to treat dump-sortings, etc. 1000 w. Min & Sci Pr—Aug. 8, 1908. No. 94330.

Stamp Mills.

Notes on the Stamp Mill Water Feed and Packed Up Dies, Introducing the Shallow Front Mortar Box. Harry T. Pitt. Gives results of trials made both with the back water feed and with packed up dies. Ills. Discussion. 2500 w. Jour Chem, Met, & Min Soc of S Africa—June, 1908. No. 94139 E.

Tube Mills.

Tube Mill Crushing. E. B. Wilson. Illustrates and describes different styles of mills, considering their use for crushing in connection with the cyaniding of slimes. 3500 w. Mines & Min—Aug., 1908. No. 94072 C.

A Laboratory Comparison of Tube Mill Pebbles. G. H. Stanley, with an Appendix on Liners, by M. Weber. Ills. 1400 w. Jour Chem, Met, & Min Soc of S Africa—June, 1908. No. 94140 E.

MISCELLANY.

Alloys.

Notes on the Metallographic Researches Carried Out at the Göttingen Institute for Inorganic Chemistry (Bericht über die im Göttinger Institut für anorganische Chemie ausgeführten metallographischen Arbeiten). G. Tammann. Gives in a table a brief *resumé* of the results so far obtained. 4500 w. Zeitschr d Ver Deutscher Ing—July 4, 1908. No. 94596 D.

Bolivia.

Through the Bolivian Highlands. E. P. Mathewson. Description, with illustrations. 1700 w. Min & Sci Pr—Aug. 15, 1908. Serial, 1st part. No. 94417.

Canada.

Minerals and Ores of Northern Canada. J. B. Tyrrell. A review of the present knowledge of the mineral resources. 6500 w. Qr Bul of Can Min Inst—July, 1908. No. 94391 N.

Egypt.

The Libyan Desert Railroad. An illustrated account of this project and its far-reaching influence in Egypt. 3000 w. Sci Am Sup—Aug. 22, 1908. No. 94424.

Geological Maps.

Note on a System of Conventional Signs for Mineral Occurrence Maps. Elfric Drew Ingall. Gives signs used by the Geol. Survey of Canada, with ex-

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planatory notes. 1500 w. Qr Bul of Can Min Inst—July, 1908. No. 94393 N.

Nova Scotia.

Development of Nova Scotia's Mineral Resources. Arthur S. Barnstead. Gold, coal, iron and gypsum are the principal products. 1500 w. Min Wld—Aug. 29, 1908. No. 94710.

Ontario.

Notes on Early Mining Endeavor in Ontario. E. L. Fraleck. A short review. 1600 w. Qr Bul of Can Min Inst—July, 1908. No. 94397 N.

Ore Deposits.

A Graphic Comparison of the Alteration of Rocks by Weathering with Their Alteration by Hot Solutions. Edward Steidtmann. A study of the chemical and mineralological changes, showing that these differences may be satisfactorily measured, and help in a better understanding of the nature of thermal solutions. 6000 w. Ec-Geol—July, 1908. No. 94300 D.

The Origin of the Silver of James Township, Montreal River Mining District. Alfred Ernest Barlow. An illustrated description of this region and conclusions from the study. 7000 w. Qr Bul of Can Min Inst—July, 1908. No. 94390 N.

The Genesis of the Copper Ores in Shasta County, West of the Sacramento River. William Forstner. Describes these deposits in California, concluding that they were formed by action of ascending thermal waters. 1200 w. Min & Sci Pr—Aug. 22, 1908. No. 94649.

The Pyritic Origin of Iron Ore Deposits. H. Martyn Chance. An examination of the evidence for and against the theory that oxidized ore bodies are the result of the decomposition of pyrite. 3500 w. Eng & Min Jour—Aug. 29, 1908. No. 94702.

The Formation of the Schneeberg Ore Deposits (Die stoffliche Zusammensetzung der Schneeberger Lagerstätten). B. Granigg. A discussion of these complex zinc-lead-copper deposits in the Austrian Tyrol. Ills. Serial, 1st part. 3500 w. Oest Zeitschr f Berg- u Hüttenwesen—July 4, 1908. No. 94558 D.

The Permian Limestone Formation Between the Diemel and Itter Valleys on the East Side of the Rhine-Westphalian Slate Mountains, with Special Reference to the Deposits of Copper, Gypsum, Iron, Manganese, Zinc, Lead, Clestine, and Barytes (Die Zechsteinformation zwischen dem Diemel- und Itter-Tale am Ostrande des rheinisch-westfälischen Schiefergebirges unter besonderer Berücksichtigung der Kupfer-, Gips-, Eisen-, Mangan-, Zink-, Blei-, Cölestin-, und Schwerspat-Vorkommen). Herr Kipper. Ills. Serial, 1st part. 5000 w. Glückauf—July 18, 1908. No. 94564 D.

See also Graphite, under MINOR MINERALS.

Panama.

The Geology of the Isthmus of Panama. Ernest Howe. 10700 w. Am Jour of Sci—Sept., 1908. No. 94741 D.

Philippines.

The Philippines. Letters describing ancient mining methods, and giving information concerning deposits of copper, gold, etc. Ills. 2000 w. Min Jour—Aug. 15, 1908. No. 94468 A.

Volumetric Apparatus.

The Testing of Glass Volumetric Apparatus. N. S. Osborne and B. H. Veazey. Gives general specifications, an account of tests made, and methods of testing, etc. Ills. 12000 w. Bul Bureau of Stand—May, 1908. No. 94308 N.

Zambesia.

More About Zambesia Minerals. Stephen J. Lett. A general review of the country, with special reference to its mineralogy, mining laws and conditions of work. Map. 3500 w. Min Jour—Aug. 22, 1908. Serial, 1st part. No. 94773 A.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Accidents.

Indiana Commission on Causes and Remedies for Railroad Accidents. Information from Bul. No. 4, for April, May and June, 1908. 1800 w. R R Age Gaz—Aug. 7, 1908. No. 94216.

Signals.

Automatic Block Signals on the Brooklyn Bridge. Plate, and illustrated description of the costly arrangement of signals adopted to insure the minimum distance between trains. 1200 w. R R Age Gaz—Aug. 28, 1908. No. 94664.

See also Switches, under CONDUCTING TRANSPORTATION.

Switches.

Mechanical and Power Switch Control (Mechanische und Kraft-Stellwerke). G. Bode. A discussion of appliances for the distant control of switches and signals. Ills. Serial, 1st part. 3500 w. Glasers Ann—July 15, 1908. No. 94577 D.

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Trains.

The California Limited. Describes this train on the A., T. & S. Fe Ry., and the country through which it passes. Ills. 2000 w. Ry & Loc Engng—Aug., 1908. No. 94097 C.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Automatic Rapid-Acting Vacuum Brakes for Goods Trains. Gives results of brake trials on the Austrian State Railway. Ills. 2000 w. Engng—July 24, 1908. No. 94159 A.

Air Pipes.

Broken Air Pipes. Shows how different breaks in air pipes can be handled to prevent engine failure. Diagram. 1600 w. Ry & Loc Engng—Aug., 1908. No. 94101 C.

Axle Lubrication.

Forced Lubrication for Axle-Boxes. T. Hurry Riches and Bertie Reynolds. Describes a system as arranged for the driving axle-boxes of some of the steam-cars of the Taff Vale Ry. Co. Ills. 1200 w. Inst of Mech Engrs—July 28, 1908. No. 94259 N.

Cab Signals.

Cab Signals in England. C. M. Jacobs. Considers systems that have been tried or suggested. Ills. 3500 w. Ry & Engng Rev—Aug. 1, 1908. No. 94125.

Cars.

The Ralston General Service Car. Views and sections, with detailed description. 1000 w. R R Age Gaz—Aug. 28, 1908. No. 94666.

New Vegetable and 20-Ton Freight Cars of the Paris-Lyons-Mediterranean Railway (Note sur les nouveaux Wagons à Primeurs et les nouveaux Wagons à Marchandises de 20 Tonnes de la Compagnie P.-L.-M.). Henri Lancrenon. Illustrated detailed description of new cars. 2000 w. Rev Gen d Chemins de Fer—July, 1908. No. 94519 G.

Electrification.

Experimental Electric Traction on the Swedish State Railways, 1905-1907. Extract from the full report of these trials and their satisfactory results. 2500 w. Engng—Aug. 21, 1908. No. 94784 A.

Locomotive Boilers.

The Care of Locomotive Boilers. F. P. Roesch. Discusses the causes of staybolt breakage and how it may be decreased. 3000 w. Ry & Loc Engng—Aug., 1908. No. 94103 C.

Diagonal Joints and Tube-Hole Rows. Discusses fully the diagonal riveted joint in boilers and lines of weakness caused by tube-holes in a drum or shell. Ills. 10000 w. Locomotive—July, 1908. No. 94798.

Locomotive Feed Water.

See Boiler Waters, under MECHANICAL ENGINEERING, STEAM ENGINEERING.

Locomotives.

Recent Narrow Gage Locomotives for Heavy Service. Illustrates and describes three recently built locomotives for tracks of 3-ft. gage. 1500 w. R R Age Gaz—Aug. 21, 1908. No. 94439.

Four Cylinder Simple Engine. Illustrates and describes a 4-6-0 engine used on the Great Western of England. 1000 w. Ry & Loc Engng. No. 94100 C.

Large Tank Locomotive; London, Brighton & South Coast Railway. Illustration, dimensions, and short description. 400 w. R R Age Gaz—Aug. 28, 1908. No. 94667.

Bogie Tank Engines, North Staffordshire Railway. Drawings and short description. 300 w. Engr, Lond—Aug. 21, 1908. No. 94786 A.

Oil-Burning Ten-Wheeler. Illustrated description of a 4-6-0 engine for the Southern Pacific Ry. 800 w. Ry & Loc Engng—Aug., 1908. No. 94098 C.

Details of Heavy Pacific Type Locomotive. Drawings and description of heavy passenger locomotives for the N. Y. C. lines. 700 w. Am Engr & R R Jour—Aug., 1908. No. 94087 C.

Pacific Type Locomotives, Chicago & Alton R. R. Illustrated description of recently completed engines. 1300 w. Ry & Engng Rev—Aug. 29, 1908. No. 94713.

The New Pacific Type Compound Locomotives of the Western Railway of France. Detailed drawings and particulars. 1200 w. Mech Engr—July 24, 1908 No. 94145 A.

A New Locomotive on the Northern Railway of France. Illustrated description of a heavy new compound locomotive. 800 w. Mech Engr—Aug. 21, 1908. No. 94764 A.

4-Cylinder Compound Locomotive, North-Eastern Railway. Detailed drawings and description. 800 w. Mech Engr—Aug. 14, 1908. No. 94459 A.

Twelve-Wheeled Mallet Compound Locomotive for North China. Illustrations and brief description of engines built in Glasgow for the Imperial Peking-Kalgan Ry. 600 w. Engng—July 31, 1908. No. 94270 A.

Compensated Locomotives. Herbert T. Walker. Remarks on early designs, introductory to a detailed description of engines of each of three classes embracing old-time locomotives of this type. Ills. 2000 w. R R Age Gaz—Aug. 14, 1908 Serial, 1st part. No. 94353.

Mountain Locomotives (Lokomotiven

mit Hilfsmotoren). Hermann Liechty. A historical review of the various types of locomotives, rack, adhesion, etc., which have been applied on heavy grades. Ills. Serial, 1st part. 2500 w. Glasers Ann—July 15, 1908. No. 94578 D.

Locomotive Stacks.

Locomotive Smokestacks. W. E. Johnston. Discusses the requirements of a smokestack formula. 1800 w. Am Engr & R R Jour—Aug., 1908. No. 94088 C.

Locomotive Stoking.

Bank Firing of Bituminous Coal. Clarence Roberts. Reply to an article on the same subject by R. G. Donaldson. 1800 w. Ry & Loc Engng—Aug., 1908. No. 94099 C.

Motor Cars.

Compound, Superheated Steam, Motor Car. Illustrated detailed description of a car for the C., R. I., & P. R. R. 1000 w. Am Engr & R R Jour—Aug., 1908. No. 94086 C.

The Petrol-Electric Drive and Other Mixed Systems. Frank Broadbent. Discusses the driving of trains by electro-mechanical or mixed systems. 3000 w. Elec Rev, Lond—July 24, 1908. No. 94151 A.

The Accumulator-Car Traffic on the Palatinate Railways. A. Giesler, in *Zeit. des Ver. deut. Eisenbahnverwaltungen.* An account of the results obtained during more than ten years trial on the main lines. 6500 w. Bul Int Ry Cong—July,

NEW PROJECTS.

Lackawanna.

The New Cut-Off Line of the Lackawanna Railroad. F. L. Wheaton. Map and description of the present lines and the cut-off, showing the improvements and saving. 2200 w. Eng News—Aug. 13, 1908. No. 94322.

Surveying.

Railway Surveying in Canada. Description from an address by Hugh Lumsden, of the surveys of the unexplored "backwoods" of north-eastern Canada. 2500 w. Engr, Lond—July 24, 1908. No. 94165 A.

PERMANENT WAY AND BUILDINGS.

Construction.

The Smyth Camp Embankment, C. M. & St. P. An illustrated account of difficult and costly railroad building, especially the construction of a large embankment by the hydraulic method. 1800 w. R R Age Gaz—Aug. 7, 1908. No. 94213.

Crossings.

Abolition of Grade Crossings in the City of New Bedford. William F. Williams. An illustrated description of the scheme as now being carried out, with a brief explanation of points of controversy. 5500 w. Jour Assn of Engng Socs—July, 1908. No. 94382 C.

Curves.

Spiral Tables of the Canadian Pacific Railway. Gives the tables used since 1894 which have given satisfaction, explaining their use. 7000 w. Eng Rec—Aug. 1, 1908. No. 94067.

Location.

Methods and Cost of Mountain Railway Location. J. J. Cryderman. Gives an outline of the work. 3000 w. Engng-Con—Aug. 5, 1908. No. 94206.

Rails.

Some Causes Which Tend Toward the Fracture of Steel Rails. James E. Howard. An illustrated article dealing with causes due to service; and with causes due to the structure of the steel. Discussion. 6500 w. Jour Assn of Engng Socs—July, 1908. No. 94383 C.

Shops.

The Great Western Railway Works at Swindon. Illustrated description of these fine works. 4000 w. Engr, Lond—Aug. 14, 1908. No. 94480 A.

Shops of the Panama Canal. Information from the *Canal Record* concerning the principal shops on the Panama Canal work. 6500 w. Ry & Engng Rev—Aug. 8, 1908. No. 94280.

The McKees Rocks Shops of the Pittsburg & Lake Erie Railroad. B. A. Ludgate. Gives the layout, cross-sections, and description. 6500 w. Eng Rec—Aug. 8, 1908. No. 94229.

Stations.

Egmore Station, Madras; South Indian Railway. Illustrated description of a fine station in India. 700 w. R R Age Gaz—Aug. 7, 1908. No. 94219.

The New Chicago Passenger Terminal of the Chicago & North Western Ry. Illustration, with detailed description of this immense structure. 1200 w. Eng Rec—Aug. 15, 1908. No. 94341.

Ties.

Wood or Steel Ties (Holzschwelle oder Eisenschwelle). A. Haarmann. A discussion of criticisms of a paper by the same author on the steel tie. Ills. 3000 w. Stahl u Eisen—July 22, 1908. No. 94556 D.

Track Construction.

Developments in Railway Track Design. Editorial discussion of suggested improvements. 2400 w. Eng News—Aug. 20, 1908. No. 94429.

The Supporting Power of Track Ballast (Ueber die Tragfähigkeit der Geleisebettung). A. Schneider. Mathematical discussion. Ills. 2500 w. Zeitschr d Oest Ing u Arch Ver—July 17, 1908. No. 94584 D.

Recent Progress in Railway Equipment

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(Recenti Progressi nella Tecnica degli Armamenti Ferroviari). Ugo Cerreit. Illustrates and describes fish-plates and chairs used in Italian practice. 2800 w. Ing Ferro—July 31, 1908. No. 94545 D.

Investigation of the Resistance Opposed to the Longitudinal Slipping of Rails by Fish Plates and Chairs (Essais sur la Resistance opposée au Glissement longitudinal des Rails par les Eclisses renforcées et par les Coussinets à Coins en Acier des Chemins de Fer de l'Etat). Ills. 1700 w. Rev Gen d Chemins de Fer—July, 1908. No. 94518 G.

Water Supply.

The Supply of Drinking Water on Trains and in Stations (La Fornitura di Acqua Potabile sulle Linee e nelle Stazioni). A discussion of the hygiene of various systems of supply. Ills. 3000 w. Ing Ferro—July 16, 1908. No. 94544 D.

TRAFFIC.

Car Interchange.

Joint Interchange and Inspection Bureaus. Gives some of the advantages claimed for the bureau plan, and the status of interchange and inspection at a number of traffic centers. 3500 w. R R Age Gaz—Aug. 7, 1908. No. 94214.

Freight Rates.

The Theory of Railroad Rates. William Z. Ripley. The present number gives an analysis of railroad expenditures. 4500 w. R R Age Gaz—Aug. 28, 1908. Serial, 1st part. No. 94668.

Reasonable Rates. William G. Raymond. An editorial letter discussing the regulation of American railroad rates. 2500 w. R R Age Gaz—Aug. 7, 1908. No. 94212.

Improvements.

Some Effects of Railroad Improvements. Shows the changes in the capacity of the railroads following improved tracks, more powerful locomotives, and cars of larger capacity. 800 w. R R Age Gaz—Aug. 21, 1908. No. 94437.

Standard Oil Case.

The Alton-Standard Oil Case. Richard W. Hale. Discusses the principles involved. 1600 w. Ir Age—Aug. 13, 1908. No. 94310.

The Alton-Standard Oil Case. R. L. Ardrey. A brief review of the facts, showing the cause of the suit, evidence submitted, etc. 2200 w. Ir Age—Aug. 6, 1908. No. 94180.

MISCELLANY.

Accounting.

Operating Department Accounts—The Basis of Accounting Department Records. Frank H. Crump. Explains the principles of a system of accurate railway accounting. 1500 w. R R Age Gaz—Aug. 21, 1908. No. 94438.

Canadian Northern.

The Canadian Northern Railroad System. An interesting account of the upbuilding of this system. 2500 w. R R Age Gaz—July 24, 1908. No. 93937.

Capitalization.

Overcapitalization. Henry Fink. Discusses the meaning of this term and recent legislation for the regulation of railroads, etc. 4500 w. R R Age Gaz—July 10, 1908. No. 93747.

France.

The French State Railways. Editorial discussion of State ownership and the results in France, the mismanagement, etc. 2500 w. Engng—Aug. 7, 1908. No. 94373 A.

Government Control.

Five Years of Railroad Regulation by the States. Grover G. Huebner. Extracts from a paper in the *Annals of the Am. Acad. of Pol. & Soc. Sci.* Classifies and analyzes the chief provisions enacted to regulate intrastate traffic. 6500 w. R R Age Gaz—Aug. 7, 1908. No. 94217.

State Control of Railroads in England. R. L. Wedgwood. From a paper read before the York Ry. Debating Soc. Considers the general situation with regard to state control over creation of the road, its construction and operation. 6000 w. R R Age Gaz—Aug. 28, 1908. No. 94665.

Government Ownership.

See France, under MISCELLANY.

Guatemala.

Guatemala's Transcontinental Route. M. A. Hays. An illustrated account of this latest line connecting the Atlantic and Pacific coasts. 2200 w. Am Rev of Revs—Aug., 1908. No. 94281 C.

Management.

Obstructions to Inventive Progress. Editorial letter criticizing the conditions which govern railroad supplies and practice in the United States. 2000 w. Ry & Engng Rev—July 25, 1908. No. 93961.

Manchuria.

From the Chinese Capital to Harbin and Moscow, via Siberia. Emil S. Fischer. On the improved conditions of travel through Manchuria, and the difficulties. Ills. 5000 w. Ry & Engng Rev—Aug. 22, 1908. No. 94498.

New England.

The New England Railroad Situation. A review of the situation and remarks on the work accomplished by President Mellen of the New Haven road. 2200 w. R R Age Gaz—July 17, 1908. No. 93821.

N. Y., P., and N.

The New York, Philadelphia & Norfolk. An illustrated account of this important short line, which has passed into the hands of the Pennsylvania R. R. Co.

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3000 w. R R Age Gaz—Aug. 7, 1908. No. 94220.

United States.

Railways: A Foundation of Wealth. G. D. Baker. Brief review of railway development and the benefits derived; especially considering statistics relating to Alabama and Arkansas. 3500 w. Mfrs Rec—Aug. 6, 1908. No. 94192.

Valuation.

Valuation of Railroad Property. Henry Fink. A brief review of methods suggested. 2000 w. R R Age Gaz—July 24, 1908. Serial, 1st part. No. 93941.

STREET AND ELECTRIC RAILWAYS

Berlin.

The Traffic Problem of Large Cities, with Special Reference to Berlin (Zur Verkehrspolitik der Grosstädte, mit besonderer Berücksichtigung der Berliner Verhältnisse). Ills. Serial. 1st part. 7000 w. Zeitschr d Ver Deutscher Ing—July 4, 1908. No. 94598 D.

Boston, Mass.

See Elevated Railways, and Interurban, under STREET AND ELECTRIC RAILWAYS.

Brakes.

The Car Equipment Department of the Interborough Rapid Transit Company—Brake Shoe Studies and Changes. An illustrated general survey of brake-shoe practice in New York City. 1200 w. Elec Ry Jour—Aug. 22, 1908. No. 94435.

Electric Braking on Three-Phase Railways, especially Mountain Lines (Ueber elektrische Bremsung bei Drehstrombahnen und besonders bei Drehstrombergbahnen). W. Kummer. An examination of the advantages of the system. Ills. 3000 w. Schweiz Bau—July 18, 1908. No. 94566 D.

Car Barns.

Reinforced Concrete Car House for Municipal Railways of Nurnberg. Reinhold Herzog. Illustrates and describes the features of interest. 1000 w. Elec Ry Jour—Aug. 1, 1908. No. 94061.

Car Repairing.

Rehabilitation of the Metropolitan Street Railway Company's Rolling Stock. Reports practice followed in the overhauling of about 800 double-truck and 500 single-truck cars. Ills. 2500 w. Elec Ry Jour—Aug. 22, 1908. No. 94436.

Cars.

Need for Lighter Cars. M. V. Ayres. Favors the reduction of weight, to reduce power consumption, stating the principles that should govern their design. 1200 w. Elec Ry Jour—Aug. 1, 1908. No. 94063.

Elevated Railways.

The Forest Hills Extension of the Boston Elevated Railway. Illustrates and describes a 2½-mile extension recently erected. 1800 w. Elec Ry Jour—Aug 8, 1908. No. 94198.

Freight Traffic.

Forms Used in Handling Freight and Express Business on Interurban Lines. M. W. Glover. Gives the methods used by the Ohio Electric Railway Co. 1500 w. Elec Ry Jour—Sept. 5, 1908. No. 94846.

History.

The History of Electric Motive Power. Prof. Silvanus P. Thompson. Abstract from paper read before the British Assn. for Adv. of Sci. A brief record of rapid development. 3500 w. Sci Am Sup—Aug. 29, 1908. No. 94640.

Tramways of the World. Sir Clifton Robinson. Read before the Tram. & Lgt. Ry. Assn. A brief review of what has been accomplished and the present prevailing conditions. 9500 w. Tram & Ry Wld—Aug. 6, 1908. No. 94452 B.

Interurban.

The Kokomo, Marion & Western Traction Co. C. A. Tupper. An illustrated description of the equipment of the new power station of this system in Indiana. 4500 w. Elec Age—Aug., 1908. No. 94290.

The Proposed Boston & Eastern Electric R. R.: An Account of Hearings Before the Massachusetts Railroad Commission. H. S. Knowlton. Map. 4500 w. Eng News—Aug. 20, 1908. No. 94426.

Long Interurban Line in Texas. Illustrated detailed description of a line to extend from Dallas to Sherman, a distance of over 60 miles, and by connections gives opportunity for an electric railway ride of over 100 miles. 6000 w. Elec Ry Jour—Aug. 1, 1908. No. 94059.

London.

London County Council Overhead Trolley Lines. Illustrated description of the Hammersmith to Harlesden tramway is given as typical of the overhead system on all this company's lines. 1500 w. Tram & Ry Wld—Aug. 6, 1908. No. 94451 B.

Rail Creeping.

Track and Third Rail Creeping. E. Goolding. Gives results of experiments and general discussion of rail movements. 2000 w. Elec Engng—Aug. 13, 1908. No. 94461 A.

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Rail Joints.

Tramway Rail Joints. Alfred H. Gibbings. Describes some methods that have been adopted to make the joint in operation as nearly as possible like the rest of the rail. Ills. 7000 w. Surveyor—Aug. 7, 1908. No. 94360 A.

San Francisco.

The Street Railway System of San Francisco. J. C. Lathrop. Illustrates and describes the work of reconstructing the lines after the earthquake and fire. Elec Ry Jour—Sept. 5, 1908. No. 94845.

Single Phase.

Single-Phase Road at Locarno, Switzerland. Illustrated detailed description of a line on which the rod collector is used. 2000 w. Elec Ry Jour—Aug. 1, 1908. No. 94060.

Some Novel Features of the Seebach-Wettingen Single-Phase Line. A short illustrated account of a road equipped with the curved-rod collector, with report of its service. 1000 w. Elec Ry Jour—Aug. 1, 1908. No. 94062.

Electric Trunk Line Operation, with Special Reference to Single-Phase Railways (Der Stand der elektrischen Vollbahnen mit besonderer Berücksichtigung der Einphasenbahnen). Fr. Eichberg. A review of recent developments and present conditions. Ills. 3800 w. Zeitschr d Ver Deutscher Ing—July 18, 1908. No. 94650 D.

Substations.

Concrete Substations in Minneapolis. Illustrates and describes examples of recent construction. 700 w. Elec Ry Jour—Aug. 29, 1908. No. 94647.

Subways.

Progress on the Subway Bridge Loop, New York. An illustrated account of the work, explaining some of the difficulties encountered. 3500 w. Eng Rec—Aug. 15, 1908. No. 94340.

Subway Ventilation.

Cooling and Ventilating the New York Subway. Abstract of the fifth report of Bion J. Arnold, which considers available methods of cooling. 2500 w. Elec Ry Jour—Aug. 29, 1908. No. 94648.

Cooling and Ventilating the New York Subway. Fifth report of Bion J. Arnold to the N. Y. Public Service Commission, dealing with present conditions, possible methods of cooling and recommendations. 3500 w. R R Age Gaz—Aug. 28, 1908. No. 94663.

Sweden.

See Electrification, under RAILWAY ENGINEERING, MOTIVE POWER AND EQUIPMENT.

Switzerland.

The Works of the Bernese Alpine Railway (Travaux du Chemin de Fer des Alpes Bernoises). Ch. Dantin. Reports progress on the Berne-Lötschberg-Simplon line. Ills. 2500 w. Génie Civil—July 18, 1908. No. 94533 D.

The Approaches to the Simplon Tunnel (Les Lignes d'Accès au Simplon). Ch. Dantin. Reviews traffic conditions in France and western Switzerland. Ills. 2000 w. Génie Civil—July 4, 1908. No. 94530 D.

The Martigny-Châtelard Railway (Le Chemin de Fer de Martigny au Châtelard). M. M. Brémond. An illustrated description of a metre-gauge mountain railway in Switzerland using the rack system on heavy grades. Serial. 1st part. 2700 w. Bul Tech d l Suisse Romande—July 10, 1908. No. 94527 D.

The Mountain Lines of the Bernese Highlands (Les Lignes de Montagne de l'Oberland-Bernois). V. Amilhau. Describes adhesion, rack, and electric lines in this district. Ills. Plate. 16000 w. Ann d Ponts et Chaussées—1908—I. No. 93608 E + F.

Track Construction.

Reconstruction of Street Railway Track at Charlotte, N. C. Illustrated detailed description of the construction. 1200 w. Eng News—Aug. 6, 1908. No. 94222.

Track Maintenance.

Roadbed Maintenance in the Slide Country. Illustrated description of troubles on an interurban line near Davenport, Iowa. 700 w. R R Age Gaz—Aug. 14, 1908. No. 94354.

Train Intervals.

Relation Between the Capacity of a Metropolitan Line and the Train Interval. G. Brecht. An investigation to find whether there is a definite ratio which gives the best results. 1500 w. But Int Ry Cong—Aug., 1908. No. 94797 G.

Trunk Lines.

Electric Trunk Line Operation (Bahntechnische Forderungen an den elektrischen Vollbahnbetrieb). Artur Hruschka. Discusses some of the questions regarding locomotives and transmission lines, etc. Ills. Serial, 1st part. 4800 w. Elektrotech u Maschinenbau—June 7, 1908. No. 93677 D.

Wire Suspension.

Catenary Trolley Construction. Oliver S. Lyford, Jr. Outlines some of the governing conditions on roads using steam for motive power during electrification and the means adopted to meet these conditions on the Denver & Interurban Railroad. Ills. 4000 w. Pro Am Soc of Civ Engrs—Aug., 1908. No. 94669 E.

We supply copies of these articles. See page 159.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated: W—Words; Anon—Anonymous.

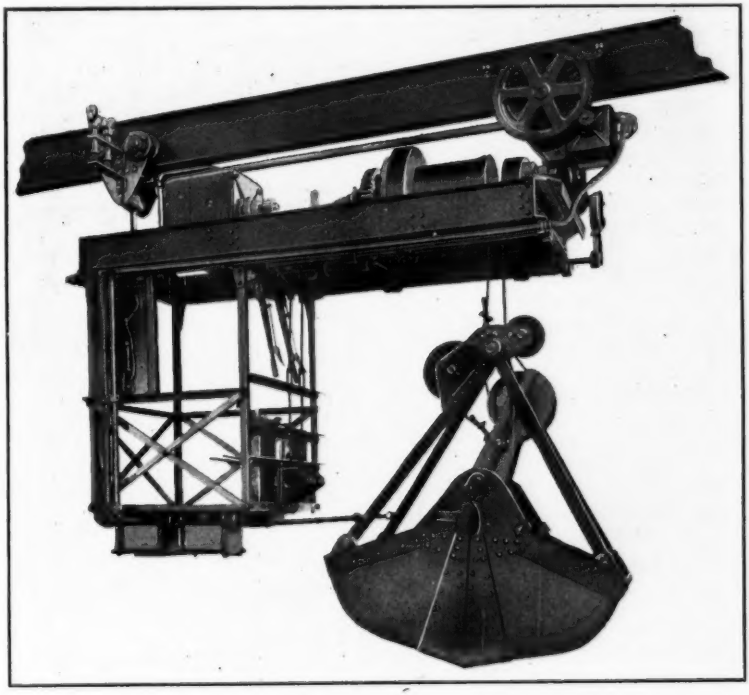
Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Camptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *w.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electric Railway Review. *w.* Chicago.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *m.* Milan.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *w.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Men. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *b-m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *w.* New York.
Railway & Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Rivista Gen. d Ferrovie *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Street Railway Journal. *w.* New York.
Surveyor. *w.* London.
Technology Quarterly. *qr.* Boston, U. S. A.
Technik und Wirtschaft. *m.* Berlin.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagon Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.

THE CURRENT RECORD OF
IMPROVED MACHINERY
NEW METHODS NEW MATERIALS
NEW APPLIANCES

Grab Bucket Mono-Rail Crane.

THE mono-rail crane illustrated herewith is for use on an I beam runway and is provided with swivel trucks so as to enable it to go around a curve of short radius. It is regularly furnished with a two-line grab bucket and is very simple and durable. Especial attention is called to the fact that both hoist and holding drums are operated by one motor, by means of friction clutches controlled from the operator's cage. The lowering of the bucket and the operations of opening and closing it are effected by gravity, this method being far preferable to a crane having a separate motor for the hoist and holding line, since the rotative speed of the armature of a series motor in lowering the load will not exceed twice the hoisting speed. With the gravity fall any speed of lowering can be attained, as the motor is inoperative when the bucket is being lowered or opened. This is an important item, especially on high lifts, and its virtues are at once apparent.



After the bucket has been lowered to the stock pile or car the clutch is closed, after which time the clutch for the holding drum is engaged and the two are utilized for lifting the load. When the bucket has reached its highest position it is sustained by a self-lubricating mechanical brake of the double friction type, thus eliminating the necessity of the constant care of the operator and the liability of dropping the bucket should his attention be interrupted at any time. In order to relieve the hoisting clutches of undue wear during the process of lowering the bucket, the hoisting drums are provided with band brakes controlled by foot levers from the operator's cage. The friction clutches used for raising the load act as safety devices in case of over-hoisting, since the clutches are so designed that they would slip before the stresses had reached a dangerous point.

The intermediate hoisting shaft is extended to the rear end of the operator's cage and is provided with a drum that rotates at about twice the peripheral speed of the hoisting drums. This drum has attached to it a rope which extends to the grab bucket and is used for steadying it, not only while in the process of being elevated, but after the bucket has reached its final position and is being carried to its destination. The rope is always kept taut by means of a friction drum revolving between two discs keyed to the shaft with feather keys and held against the drum by means of spiral springs made adjustable for wear and also to vary the pressure between the friction services. The strength of the springs is such as to exert a pull on the steady rope of from two hundred and fifty to three hundred pounds as the bucket is being raised or lowered.

A racking motor is attaced to the driving truck and its speed is regulated by a drum type controller located in the operator's cage. The travel of the hoist may be made to suit almost any condition, but in ordinary practice a speed of from three hundred to five hundred feet per minute will be found sufficient for coal handling plants, especially where there is a curve of bend in the I beam along the runway.

The treads of the track wheels for the driving and trailing trucks are made spherical instead of cone shaped as is sometimes done, the object being to eliminate friction as far as possible, as it is well known that a cone shaped wheel running on the lower flange of an I beam will have rolling contact along one diameter only, while the other parts of the wheel will be in sliding contact and subjected to undue wear, as well as imposing an excessive load on the racking motor.

While compactness is desirable it was considered by the designer to be of secondary importance to accessibility, and although the first has been obtained in a remarkable degree it was at no sacrifice of the second characteristic. In fact the result is a very creditable combination of the two features.

None of the points so far mentioned is of any greater importance than ample strength and reliability, and no hoist, however ingenious, convenient or commendable in other particulars, will be a success unless it is mechanically sound and sufficient for its work. Since a coal handling crane of this type is designed principally for light and medium loads and is intended to be operated by unskilled workmen, it must be capable of withstanding without injury large overloads and inconsiderate handling. The design of the mono-rail hoist is favorable to the making of all parts of unusual strength. This and the making of all wearing surfaces larger than is usually considered necessary has been found possible without exceeding the dimensions and the weight that are considered standard for other hoists of the same rated capacity. The hoist of the type shown herewith was designed to handle from twenty to thirty tons of coal per hour from a car or stock pile about one hundred and fifty feet distant from the power house, with a vertical lift of about sixty feet.

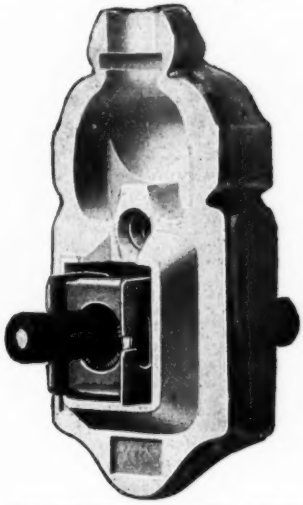
The advantages claimed for this class of coal handling machinery are low cost of handling material, as only one man is used to load the bucket, carry it to its

destination, empty it and return it to the point of starting; low cost of installation; a low maintenance charge on account of the small number and size of the working parts; large area served; and low power consumption.

The mono-rail hoist was designed and built by the Cleveland Crane & Car Co. of Wickliffe, Ohio, under the direction of Thos. B. Davis, M. E., chief engineer.

New Push-Button Specialties.

THE Cutler-Hammer Mfg. Co., of Milwaukee have recently introduced a new line of push-button specialties which is interesting as marking a decided advance in switch construction, the mechanism consisting of but three moving parts. The principle involved is that of a coiled spring contracting on a tapering surface and is entirely new. The moving parts are a push bar extending clear through the switch, the coiled steel spring referred to and a moving contact piece. These with the fixed contacts constitute the whole of the mechanism. The action is very similar to



MECHANISM OF PENDENT SWITCH.

that of the common rubber ring slipped over the knob of an umbrella or a coiled wire sleeve supporter which, when passed over the elbow, will travel a short distance up or down the arm, following the course of least diameter. The movement of the spring is very rapid and positive in either direction, so that this mechanism gives an equal make or break,

INTERIOR OF PENDENT SWITCH.

the movement of the contact piece being the same whether the push bar is moved fast or slow.

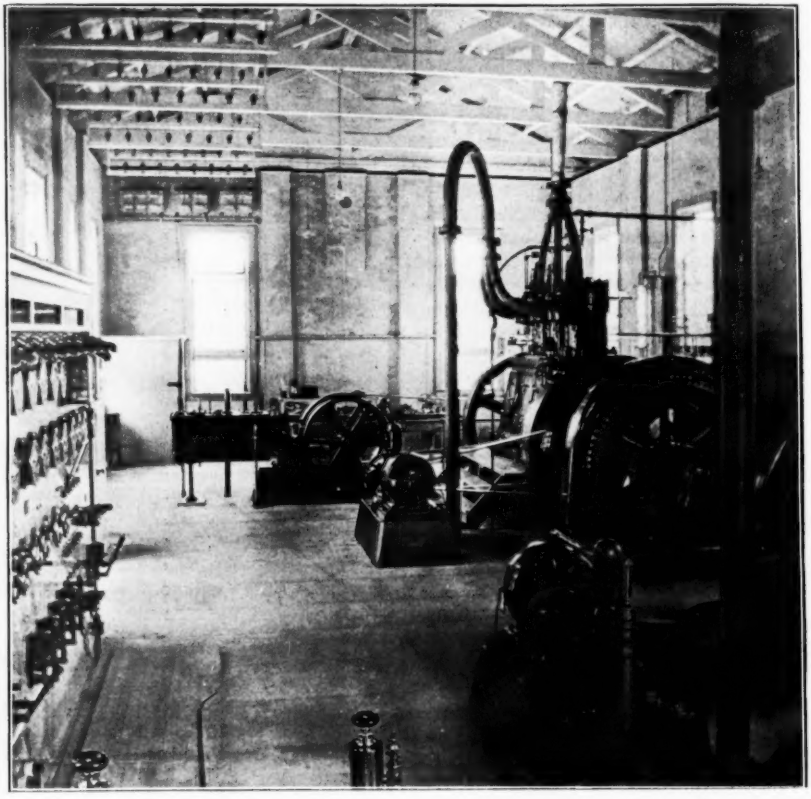
The makers have designed an interesting little vest-pocket model of the mechanism which they will send with full descriptive matter upon request.

Electric Plant at Coeymans, N. Y.

THE Atlantic Light & Power Company, at Coeymans, N. Y., was organized in response to a demand for a better lighting service. As a municipal plant was not legally possible, the leading citizens of Coeymans, Ravena and New Baltimore organized this company. The Coeymans plant supplies street and commercial lighting in Coeymans, Ravena and New Baltimore, and lights the station and yards of the West Shore Railroad at Ravena. The street lighting system consists of over two hundred 40 candle power tungsten lamps on a series circuit, which are carried on a contract

of $20.00 per lamp per year. The railroad uses twenty-one arcs and two hundred incandescents on multiple circuits. The present commercial lighting load is about two hundred tungsten lamps, which the company furnishes to consumers at cost, and about fifteen hundred 15 candle power incandescents. The lighting rate is 12c. per kilowatt, with a sliding scale of discounts.

The power service has not yet been



developed, as the plant has been in operation only since February. Preparation has been made on the switchboard, however, for a power circuit. The power rate will be from 10c. down to 2½c. per kilowatt.

The power plant contains two duplicate 85 kilo-volt-ampere sets, making a total capacity of 170 kilo-volt-amperes. It is intended, however, that only one set shall be used at a time, the other being kept as a spare. In case of an increase of the load beyond the capacity of one set, duplicate additional sets will be installed. This provision has secured many customers for the concern, as it assures continuous service. The fact that the Crocker-Wheeler generators used are easily parallelel obviates the sudden fluctuations which were had with the old service when throwing the load from one generator to another. The generating sets consist of Crocker-Wheeler generators coupled direct to Diesel oil engines. The engines, each rated at 120 horsepower and having three cylinders, 12 x 18, were built by the American Diesel Engine Co., of New York. They burn crude oil, which is injected into the cylinders by means of compressed air at a pressure of 900 lbs. For this purpose

each engine has belted to it an Ingersoll-Rand 9¼ x 3 x 10 two-stage compressor. Cooling water is circulated by a Pyramid 4 x 5 pump, belted to each set.

The 7,500 gallon oil tanks are located about thirty feet from the building. These are buried in the clay soil to exclude water due to sweating. In addition a 10,000 gallon tank is provided at the railroad, from which the oil is carried to the storage tanks in a tank wagon. A 14,000 gallon cooling tank is installed at the rear of the building. This is of wood, supported on a concrete foundation. The water is delivered as a spray at the top of a series of wooden steps down which it is allowed to drip to the tank.

The generators are 32 pole, 85 K. V. A.. 2,300 volt, 2 phase, 60 cycle machines at 225 revolutions per minute. They were built by the Crocker-Wheeler Company, of Ampere, N. J., and are of the same general type as the larger machines built by the same company, which operate particularly well in parallel with each other or with machines of other types. The winding of the revolving field consists of strip copper wound on edge, which affords radiating surface for each turn of the winding, thus insuring cool running. The ventilated type of core and housing also insures thorough circulation of air. The use of magnetic wedges in the core slots is a feature of these generators. It permits the use of form wound and pre-insulated coils and solid pole shoes. The exciter belted to each generator is a Crocker-Wheeler, Form I, 6.5 K. W., compound wound generator, running at 1,100 revolutions per minute.

The switchboard is arranged in six panels of blue Vermont marble, 90 inches high and with a total length of about 12 feet. The panels are of the Crocker-Wheeler type 12. The first two panels at the left are combined generator and exciter panels. The next two are feeder panels, each containing two single phase circuits. Of these, one circuit is provided for commercial lighting in each of the villages of New Baltimore, Coeymans and Ravena, and the fourth circuit supplies the railroad lighting. Each of these circuits contains a Crocker-Wheeler single phase feeder regulator, capable of regulating the voltage of the circuit 10 per cent. above or below the bus-bar voltage. The fifth panel contains three 150 light series incandescent systems, for street lighting, with Wood regulators situated behind the board. Intergrating wattmeters are provided on this panel, to check up the cost of the street and commercial lighting.

The pole line is of such height that the wires are suspended above the lines of the telegraph and telephone companies. All lines are provided with lightning arresters at the switchboard, at the first pole and at various points along the lines. All guy wires are provided with strain insulators to protect pedestrians, and pole transformers are grounded. Street lamps are permanently suspended from the poles on six foot and eight foot arms of one inch pipe, from the ends of which the lamps are insulated by means of glass petticoat insulators in best Philadelphia fixtures, with General Electric sockets and receptacles.

The cost of fuel and lubricant for the engines is very low, not exceeding 40 gallons of fuel and 1½ gallons of lubricant per day for a run of about 60 horsepower for 10 hours and very light load for the other 14 hours.

A New Finish For Steel Tapes.

THE Keuffel & Esser Co., 127 Fulton street, New York, has recently applied to its extensive line of steel tapes a new finish, known as the "Keco," which produces an excellent contrast between the graduations and the background. The background is jet black and the graduations stand out with remarkable clearness, a feature which adds greatly to the ease and convenience with which measurements are made. In addition to this advantage, the new finish is absolutely unaffected by exposure to moisture and effectively prevents rusting, so difficult to guard against in ordinary tapes. The brilliancy of the finish is not impaired by handling with moist hands.

The tapes to which the "Keco" finish is applied are remarkable for their com-

pactness, and possess the other characteristics which have made the tapes manufactured by this firm so widely and favorably known. Prominent among these is the compensated centers device, which may be adjusted for wear after long use, so as to give just the friction required for the proper winding and unwinding of the tape, a feature which results in materially longer life for the latter.

Obermayer's Molding Machine Snap Flask.

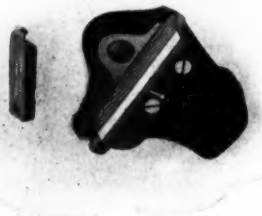
THE new flask for machine molding, recently put on the market by the S. Obermayer Co., combines every good point needed in a flask of this kind. Made of 1⅛ inch kiln-dried cherry, grooved, machine locked corners, bound top and bottom with iron bands securely screwed to the flask, solid corners welded, a perfectly rigid flask is secured. The corner plates are of extra heavy

malleable iron. Hinges are also malleable with machined bearings the entire length of the flask. The hollow V-shaped pin and guides insure close contact and permit the sand to drop between the pin and flask. The snap used on this flask is simple, strong and efficient, and made either in the hook or lever type. Further information and prices may be had by addressing The S. Obermayer Co., at their Cincinnati, Chicago, or Pittsburgh offices.

New Bolt Cutter Die Head.

THIS machine, and especially the die head, has been designed to meet the demands for a bolt cutter for high speed work and one that will give accurate results as well as admit of flexible rake in the die, accommodating the die to the various kinds of material that come up in daily practice. The head is made entirely of steel, the heavier parts being made from cast steel, the spindles from high grade machinery steel, and the smaller parts from tool steel. All the

main bearing parts are hardened and ground and all interchange readily. The die head is symmetrical, very compact, and all parts are easily accessible. The die locks within the head and the yoke is not relied upon to hold the die closed while cutting or for carrying any of the cutting strain. In fact, the yoke plays freely and is not locked at all. This makes it very simple for attaching to other makes of machines, as well as requiring much less attention along the line of adjusting than is required by the average die head.



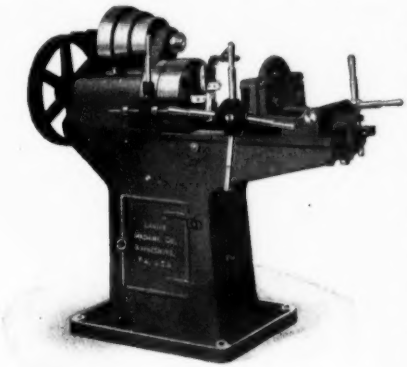
A spring engages the chaser holders and gives quick and positive opening to the die and at all times takes up the back-lash that might possibly occur from slight wear. This spring is made with one coil so as to give it a uniform tension in its different positions.

The holders carrying the dies are also made of steel. The cut shows one of these holders with chaser in position and the small hook gauge used for determining the correct cutting position of the

chasers after grinding them. The chaser is supported close up to the cutting point and is backed in such a manner as to prevent any canting or becoming bell mouthed.

A clamping bar engages a dove-tailed slot in the back of the chaser in such a manner as to draw it down and back at the same time by means of the two screws shown on the face of the chaser holder. The chaser is also supported on the rear by a screw which helps hold it in correct cutting position. By means of this screw the chaser can be set forward as fast as worn or ground off.

Any rake can be given the dies in grinding that may be desired to suit the kind of material you may wish to cut. This rake can readily be ground to get a rolling chip at all times, the same as would be procured from a lathe tool. This flexible rake makes it easy to acquire the highest possible cutting speeds that can be had from any die, as the



cutting clearance in the die is correct and there is no possible drag in the die. The bevel on the chaser forms the throat of the die, and no grinding is ever done on this bevel at all. The depth of the throat can be made to suit special requirements, where it is necessary to cut close to shoulders or heads of bolts. You can cut just as close to shoulder when the die is almost worn out as when it is new. The chasers are hard their entire length and to resharpen means a simple grinding operation, which grinding is at all times done on the ends of the chasers; and very many grindings can be had on one set of dies before they are too short to hold.

These dies can be made to advantage from high speed steel, especially as they never require to be annealed, hobbed or retempered, thus eliminating much of the annoyance common in the hobbed die. Aside from this fact they have a life far in excess of any other. Another feature of especial value in this die is the fact that the back teeth can not shave the thread, but the back teeth of the four chasers act as a lead nut to draw the work in correct to the pitch of the die, and if required special dies will be furnished with a fine degree of accuracy guaranteed.

With this die cutting speeds have been produced more than 100 per cent. in advance of the ordinary hobbed die, due to the fact that the die has correct cutting clearance, flexible rake, and does not have any drag, giving the most ideal cutting conditions that can be had on any tool. The die is opened and closed in much the same manner as in all ordinary bolt cutters, either by hand or by the movement of the carriage. The carriage has special advantages of adjustment either up or down or sidewise. It is gibbed to the bed in such a manner that it can be readily adjusted to compensate for any wear that may occur. The vise has guides centralized over the bolt being cut, with clamping screws immediately below, thus eliminating side thrust. The rack is central of the machine and immediately below the line of the bolt being threaded, and the grips provided with the machine can be turned four ways for holding different sizes or shapes of stock.

The main spindle of the machine is so arranged that any oil running in through the head can not run out on the floor in the rear, but will pass back into the oil tank again. All machines are provided with rotary oil pumps with spring release valve.

When desired tap chucks can be put on the heads in place of dies to form chucks for holding taps, and one set of chucks will cover the entire range of the machine and can be adjusted in the

same manner that you adjust the head and set the dies to different sizes. It is not necessary to stop the machine to take a nut tap out or put one in again.

These machines are built by the Landis Machine Co., Waynesboro, Pa., U. S. A., in single, double or triple heads, with either belt or motor attachments, and the same type of die is also used by these people in their pipe threading machines, which have been meeting with very marked success.

Flint-Rim Sprocket Wheels.

THE sprocket wheel illustrated by the accompanying sectional view has been developed to meet the requirements imposed by the handling of abrasive materials, and by working-conditions too severe for the employment of the regular type of cast-iron wheel. The teeth and rim exposed to the wearing action of chain contact are hardened to a considerable depth, and the surface made

CROSS-SECTION OF FLINT-RIM SPROCKET WHEEL.

smooth and uniform. This improvement in sprocket wheels not only makes the wheel more durable, but actually prolongs the life of the chain by maintaining the original accuracy of fit between the links and the sprocket teeth. The makers, the Link-Belt Company, Philadelphia, have coined and protected a trade-name, "Flint-Rim," for the new wheels, which are announced as available in most of the active sizes of the "Ewart" type of chains.

The Jeffrey Crab Locomotive.

THE Jeffrey Manufacturing Company, of Columbus, Ohio, has recently added to its line of electric mine locomotives, a new type of gatherer known as the Jeffrey crab locomotive. The gathering locomotive commonly used is provided with a reel of flexible insulated conductor which enables it to enter the rooms for the purpose of delivering empty mine cars to the working places, and for hauling out the loaded cars. When the rooms are driven to the dip on steep grades, however, it is difficult for a locomotive which has to enter the room, to work efficiently against the grade. Again, where the tracks are practically level and the cars are not heavy, it is found economical to push the empty into the room by hand, so that mechanical means are required only for hauling out the loaded cars. The advantages of employing in such cases a locomotive capable of pulling out the loaded cars without entering the rooms, has prompted the Jeffrey Mfg. Co. to bring out this crab locomotive, so named from a small winding drum or crab which is mounted on the forward end of the locomotive. Three hundred and fifty feet of ⅜-inch flexible wire cable wound on this crab is used for pulling the loaded cars from the rooms and out onto the entry tracks. There are several methods of operating this locomotive to advantage, the choice depending upon the system of mining followed where the locomotive is used. With the double entry system, the locomotive usually hauls a trip of empty cars into one entry and drops them off at the rooms where they are required. Returning on the other entry, it stops in front of each room where a loaded car is ready. The trip rider then drags the cable into the room, attaches it to the car and signals the motorman, who starts the crab motor and pulls the car out to the entry track. The locomotive then either pulls it to the next room or leaves it standing until as many cars have been drawn from the rooms as are required to make up a trip. Then it pushes them together, they are coupled up, and hauled to the partings. On the return trip, the empty cars are distrib-

uted in the entry from which the loads have just been removed, and the locomotive gathers the loaded cars from the entry which was supplied with empties on the preceding trip.

Where the single entry system is employed, the locomotive usually runs in with a train of empties. Stopping successively in front of the rooms in which loaded cars are ready, it hauls each car to the empty track and pushes it ahead to the next room, dropping off an empty to replace each loaded car taken out. When all empties have been distributed, it then proceeds to the parting with the loads gathered. By each of these methods a locomotive can gather from 75 to 200 cars per day, depending upon local conditions. The crab device is made as compact as possible, to avoid crowding the rest of the locomotive equipment. It consists of a cast iron drum upon which a steel cable is wound. This is mounted on a vertical axis and is contained in a frame, the top of which supports the motor which is connected by suitable gearing and a friction clutch to the drum. The motor drives this gearing through a worm and worm wheel, so that when it stops the gearing is locked against further motion. The drum is driven by the gearing through a friction clutch which acts not only as a smooth starting device for the cars, but also as a safety device in case a car becomes derailed or the motorman fails to throw off power until the car bumpers strike those of the locomotive. Without this friction arrangement the cable would, in such cases, break, or serious injury would result to the gearing or motor itself.

The motor which actuates the crab being entirely separate from the locomotive motors, is controlled by a separate starting box, and when the car approaches the entry tracks, the motorman starts the locomotive ahead. As it advances past the switch points, the car follows and runs out upon the entry tracks without either the locomotive or the winding of the crab being stopped.

The crab may be stopped when the car

strikes the locomotive, but the locomotive need not stop until the room is reached from which the next load is to be hauled. Then the trip rider uncouples the cable and drags it into that room for the car. The arrangement is such that the cable may be paid out from either end of the locomotive. Ordinarily, however, it is more convenient to take the cable out past the motorman, as that end of the locomotive is then opposite the room mouth, and the motorman can watch the light carried by the trip rider, and can see him signal to start winding. He can also watch the car to better advantage as it takes the switch, and can stop instantly if it should become derailed.

One great advantage claimed for the crab locomotive is that, except where

there are rooms driven to the rise at so great a pitch that the cars cannot be pushed into them by hand, it may replace animal haulage at once without making any changes in the tracks or conditions in the rooms. When the rooms are driven to the rise and it is necessary for the locomotives to enter them in order to push the empty cars to the working places, a gathering locomotive, many types of which are made by the same company, is necessary, as ordinarily it is impracticable to use the crab device for hauling cars into rooms.

Nugent Gravity Oiling System.

THE accompanying illustration shows a Nugent gravity oiling system attached to a Corliss engine by William W. Nugent & Co., 20 West Randolph street, Chicago. In the Nugent system the oil is fed from a tank (marked A in the illustration) mounted upon one of the standards and feed pipes, marked B. This tank is provided with a gauge glass and valve. The location of the tank is optional, and it may be placed, if desired, on the wall near the throttle valve, so that the engineer, when he starts his engine, may reach over and turn on the oil. All oil cups are dispensed with in such a system and much oil and labor are saved. All important bearings about the engine are supplied with oil from one reservoir, there being sight-feed regulating valves at each bearing. All reciprocating bearings, such as the crank pin, the cross-head pin and the eccentrics are supplied with Nugent's crank pin and telescopic oiling devices and are in constant communication with the oil supply at all times, which insures positive lubrication, no waste of oil and a saving in repairs and no shut-downs. The makers will furnish full information on request.

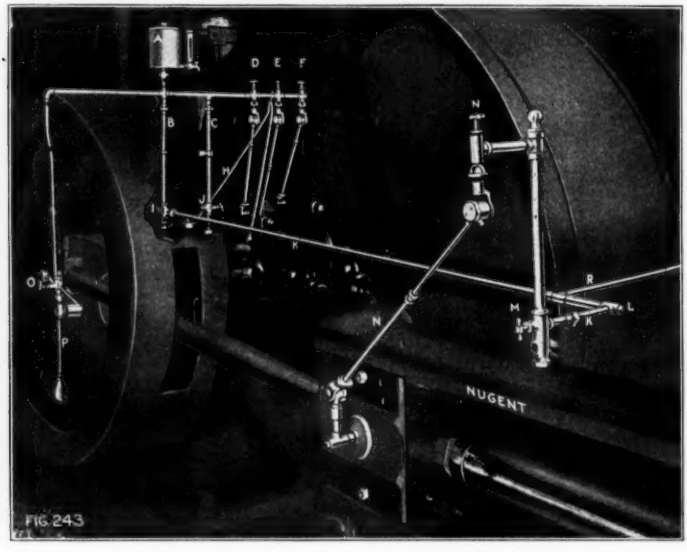


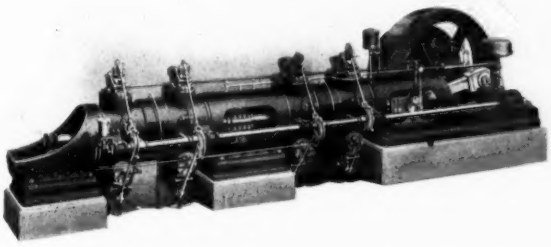
FIG. 243

Buckeye Gas Engines.

THE accompanying illustration shows the latest design of the four-stroke cycle double-acting tandem gas engine as made by the Buckeye Engine Co., Salem, Ohio. The makers of this engine prefer the term four-stroke cycle to the term more commonly used—four-cycle.

The fundamental principles of construction in this engine are utility and simplicity, the Buckeye gas engine being designed in the simplest and most direct manner to meet the requirements of

utility, rigidity and convenience. The placing of the admission valves on the top and the exhaust valves at the bottom of the cylinder allows ready drainage of



the oil and other deposits directly through the exhaust valves. Furthermore, in this type of engine it has been found best to have the exhaust and admission valves widely separated, for the reason that where both valves open into the same space the fresh charge entering the cylinder through the chamber surrounding the exhaust valve is heated and largely expanded, thus decreasing the weight of the charge and reducing the power of the engine.

In the larger sizes the cylinders are made in halves, bolted together in the center, but in the smaller sizes they are made in a single casting. The metal of the working barrel is continuous from end to end, but the water jacket has an opening entirely around the circumference. This permits of free expansion and contraction under the varying temperatures to which the cylinder is subjected. The opening in the water jacket is closed water tight by means of a cast-iron band, which is drawn tightly around the cylinder. This band compensates for sliding without causing any strains in the structure.

The main frame is anchored firmly to the foundation, but the rest of the machine is free to slide on fixed guides on cast-iron bases which are shown in the illustration under the center distance piece and rear stub. Owing to the difficulty of maintaining perfect alignment and the weakness of center crank shafts this engine is built side-crank construction. The systems of mixing and distribution, ignition, timing, regulation, compression, etc., are all interesting, and the builders have compiled an extensive illustrated description of the entire engine which they will be glad to send upon request.

Personal.

—Eagleton Hanson, for the past twenty-nine years secretary of the Trenton Iron Co., died recently.

—C. S. Kiessling, who has been employed in the general offices of The American Steam Gauge & Valve Mfg. Co., Boston, for several years, has been transferred to their Chicago office and will have charge of the order department.

—J. G. Holcombe has resigned the position of division engineer in charge of the Municipal Engineering Division of the Isthmian Canal Commission in Panama, taking effect September 1, 1908, to accept the office of chief engineer and director of Public Works of the Republic of Panama.

—Gardner Dexter Hiscox, well known as a writer on scientific subjects, died recently at East Orange, N. J. He was best known as the author of "Compressed Air and Its Application," "Modern Steam Engineering," and "Hydraulic Engineering." He was a member of the American Astronomical Society.

Industrial Notes.

—The Raymond Concrete Pile Co., New York and Chicago, has been awarded the contract for placing Raymond concrete piles in the foundations of the Frederick Grunden Branch Library, Cass Avenue and 14th Street, St. Louis.

—A new office has been opened in the Gumbel Building, Kansas City, Mo., by

Crocker-Wheeler Co., Ampere, N. J., for the sale of C-W motors, dynamos, transformers, switchboards, etc. The office is in charge of A. W. Paine.

—The Schaeffer & Budenberg Mfg. Co. announce that they have sold their factory buildings at Foxboro, Mass., and that their main office, works and New York salesroom will be located at 963-965 Kent Ave., Brooklyn, N. Y.

—The contract for placing Raymond concrete piles in the foundations of the Trumbull School at Foster and Ashland Avenues, Chicago, has been awarded to the Raymond Concrete Pile Co., New York and Chicago.

—The National Society for the Promotion of Industrial Education announces that its next annual meeting will be held at Atlanta, Ga., November 19, 20 and 21. The first day will be devoted to the meetings of State Branches and State Committees and to the annual meeting of the Georgia Branch.

—The story of alundum is told in a booklet just issued by the Norton Company, Worcester, Mass. It treats of the raw material, the process of manufacture, the electric furnace, the advantages of alundum over natural abrasives and the reasons alundum is used in the manufacture or Norton grinding wheels.

—Turner Construction Co., 11 Broadway, New York, have recently been awarded the general contract for the construction of a reinforced concrete warehouse one story high, 90′ x 100′ in plan, for the Hardy-Voorhees Company, at Metropolitan Ave. near Newtown Creek, Brooklyn. This building will have 30′ clear spans.

—The Troy, New York, works of the Sirocco Engineering Company are now turning out fans for the forced draft equipment of the United States battleships "Delaware" and "North Dakota." These fans, fourteen in number for each ship, are 27 inches in diameter and will be driven by General Electric motors.

—The controlling interests in the Canton Art Metal Co., Canton, Ohio, are erecting a rolling mill at Massillon, Ohio, where they will operate a six mill plant, to be increased as business demands, and expect to be in operation about the first of the year. They will operate a galvanizing plant in connection, and will manufacture black and galvanized sheets in the different gauges.

—A new machine shop and foundry is under construction for the Goldschmidt Thermit Co., 90 West Street, New York. The building occupies a site, 34 x 90 feet in size, just back of their present factory in Jersey City, and is to be fitted up for the purpose of handling to better advantage the repair work which is now being carried on at these works. Traveling cranes will be provided.

—Columbia University will offer at night during the year 1908-09 twenty evening courses specially adapted to the needs of technical and professional workers. This includes work in applied mechanics, applied physics, architecture, electricity, fine arts, industrial chemistry, mathematics, and surveying and structures. The work begins on October 26, and continues for twenty-five weeks. A full description of the courses is contained in the Announcement of Extension Teaching, which may be obtained on application to the Director of Extension Teaching, Columbia University, New York City.

—*The General Electric Review* for September, published by the General Electric Co., Schenectady, N. Y., contains the following articles: Alternating Current Underground Distribution, Part II, S. D. Sprong; The Rise and Progress of Electrical Science, W. S. Andrews; The Advantages of the Variable Speed Motor for Driving Testing Machines, J. A. Capp; Greenfield Electric Light and Power Co., Greenfield, Mass., Ira M. Cushing; Controlling Board for the Power Plant of the Salt River Project, S. E. M. Henderson; Heating Stand for Electric Flat Irons, John Liston; Rotary Converters, Part VII, Ernst J. Berg; Automatic Control Apparatus, Hudson Terminal Building, C. D. Knight; Ventilation of Steam Turbine Stations, W. J. Foster; Arc Lighting System of Portland, Oregon, B. C. Coldwell; An Isolated Plant, 3-Wire Switchboard, D. H. Plank, and Notes.

—The increasing use of small Curtis steam turbines is shown by an inspection of a partial list of turbines under 500-kw. capacity which up to the present time have been installed by the General Electric Com-

pany or are under construction. Of the 570 odd turbines listed, representing a total capacity of about 37,000 kw., 7 per cent are for the export trade. The remainder are intended for domestic service in central stations, marine work, laboratories of educational institutions, power and lighting plants for hotels and office buildings, laundries, mines, printing establishments and in every branch of manufacturing. Turbines for train lighting are finding a ready market and it is interesting to note that the leading railroads are using this method of train illumination. The latest application of moderate size Curtis turbines is for driving fire pumps, in which capacity they have been very satisfactory. On board ship where a compact generating unit is required, small turbine lighting sets are also rapidly coming into favor.

—"A Few Coal Facts" is the title of a folder just issued by the Harrison Safety Boiler Works, 3138 No. 17th St., Philadelphia, Pa. The sub-title states that "six boilers can make more steam than seven," and in support of this startling announcement it is pointed out that the six boilers can do it if they are fed with water from a Cochrane heater, at 208° F., while the seven boilers are fed with cold water at 60° F. It is further shown that the heater will reduce the consumption of coal and raw water at least one-sixth, and that the heater will perform the functions of oil separator, expansion tank, hot well, receiver pump, raw water regulator, pump governor and return tank, in marked contrast to a closed heater which would be useful only to partially heat the water. The final chapter is devoted to the subject of scale and acid in the boilers, and it is pointed out that with the hot process system of water purification supplied by this Company only one chemical is needed, the necessity for lime or caustic soda being done away with. The pamphlet is illustrated by views of Cochrane heaters, a diagram showing the disposition of heat in a steam plant, and a view of a hot process softening system apparatus.

—Among recent orders taken by The Ohio Blower Co., Cleveland, for their Swartwout cast iron exhaust heads are the following: one 16-inch to Indiana State Reformatory, Jeffersonville, Ind.; one 14-inch to Hanover Light, Heat & Power Co., Hanover, Pa.; one 12-inch to Brown Cracker & Candy Co., Dallas; Hughes High School, Cincinnati, one 8-inch; Home Insurance Building, Chicago, one 8-inch; one 7-inch to Eastman-Gardiner & Co., Laurel, Miss.; one 6-inch to International Milk Products Co., Cooperstown, N. Y.; two 5-inch to La Crosse Plow Co., La Crosse, Wis.; one 5-inch to Madisonville High School, Madisonville, O.; one 5-inch to Philip Vogelmeier, Newark, O.; one 5-inch to Kibbe Bros. Co., Boston; and others to High School Building, Auburn, N. Y.; Speed Changing Pulley Co., Anderson, Ind.; Williams & Bangs, Boston; L. C. Egbert, New Carlisle, Ind.; Central Machine Works, Lancaster, Pa.; Cahill-Swift Mfg. Co., St. Louis.

NEW CATALOGUES AND TRADE PUBLICATIONS

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index. See page 11.*

Air Compressors.

CHICAGO PNEUMATIC TOOL CO., Fisher Bldg., Chicago—Catalogue No. 26 illustrating and briefly describing air compressors suitable for operating pneumatic chipping, calking, riveting and stone cutting machines, drills, reamers, etc. Also contains tables giving dimensions, weight, etc. 6 by 9 in.; pp. 28.

Air Washer and Humidifier.

BUFFALO FORGE CO., Buffalo, N. Y.—Catalogue No. 97 contains a complete description, with illustrations, of air washers and humidifiers, the different uses to which they may be adapted and the advantages to be derived from their use. 6 by 9 in.; pp. 36. Also a pamphlet treating of air moistening for silk factories. 3½ by 6 in.; pp 12.

Ammonia Fittings and Supplies.

ARCTIC ICE MACHINE CO., Canton, O.—Catalogue illustrating and describing such fittings and supplies as are generally used in the construction of ice making and refrigerating plants. Also gives sizes, prices, etc. 6 by 9 in.; pp. 52.

Automobile Instruments.

GENERAL ELECTRIC CO., Schenectady, N. Y.—Bulletin No. 4612 illustrates and describes a combination ammeter and voltmeter enclosed in a dust-proof and moisture-proof aluminum case.

This bulletin will be of interest to owners of electric automobiles. 8 by 10½ in.; pp. 4. Also a pamphlet entitled Transformer Steel, giving a brief history of the material used in transformer construction, and calls attention to type H transformer in the manufacture of which the described steel is used. 5¼ by 7¾ in.; pp. 8.

Boilers.

CONTINENTAL IRON WORKS, West and Calyer Sts., Brooklyn—Cloth bound catalogue treating of the Mouson suspension furnaces for internal furnace boilers. Contains much valuable data, with numerous illustrations, including a number of important installations of internal furnace boilers using Mouson suspension boilers, together with details of design and construction, tables of pressure and thickness, and rules for calculating same. 9 by 11½ in.; pp. 68.

Boring Mills.

NILES-BEMENT-POND CO., 111 Broadway, New York—Well-printed catalogue illustrating and describing boring and turning mills. Also contains specifications in both English and metric dimensions. 9 by 12 in.; pp. 46.

Concrete Piles.

RAYMOND CONCRETE PILE CO., 135 Adams St., Chicago—Catalogues descriptive of the Raymond system of concrete piling. It treats of the method of making piles, the advantages of the tapering shape, the economies, placement, reinforcement, carrying capacity, cost, standard sizes and specifications. 6 by 9 in.; pp. 22.

Drills.

HACKETT HIGH SPEED DRILL CO., 90 West St., New York—Catalogue No. 4 contains an illustrated description of high speed drills. Also contains prices and tables of cutting speeds. 6 by 9 in.; pp. 8.

Electrical Supplies.

W. R. OSTRANDER & CO., 22 Dey St., New York—Catalogue illustrating and describing, with prices, electric bells, batteries, burglar alarms, gas lighting material, heating specialties, fans; watchmen's clocks; arc and incandescent lamps; telephones and telephone systems; telegraph instruments; novelties, automobile supplies, etc. Fully indexed. 6 by 9¼ in.; pp. 690.

Feed Water Heaters.

ECLIPSE FEED WATER HEATER & PURIFIER CO., Oshkosh, Wis.—Catalogue illustrating and describing heaters and purifiers for heating and purifying feed water for boilers and other purposes. 6 by 9 in.; pp. 20.

Friction Clutches.

WILLIAMS FOUNDRY & MACHINE CO., Akron—Bulletin D is devoted to an illustrated description of friction clutches, together with price list. 8 by 11 in.; pp. 4.

Indicators.

AMERICAN STEAM GAUGE & VALVE MFG. CO., 220 Camden St., Boston—Catalogue devoted to an illustrated description of the Thompson improved indicator, together with prices. Also contains numerous testimonial letters. 6 by 9 in.; pp. 70.

Measuring Tapes.

KEUFFEL & ESSER CO., Hoboken, N. J.—Supplement to their Trade Price List in which several new steel tapes are listed and described. 6 by 9 in.; pp. 8.

Mine Hoists.

FOOS GAS ENGINE CO., Springfield, Ohio—Circular No. 77 describes hoists for mining, contracting and general purposes. The circular is well printed and illustrated. 9 by 7 in.; pp. 8.

Oil and Grease Cups.

D. T. WILLIAMS VALVE CO., Cincinnati—Pamphlet illustrating and describing oil and grease cups for engine and machinery bearings. Prices, dimensions and directions as to use are also given. 3½ by 6 in.; pp. 24.

PHILADELPHIA LUBRICATOR & MFG. CO., The Bourse, Philadelphia—Booklet giving some important facts accounting for the large economy grease cups produce. Illustrated. 3½ by 6½ in.; pp. 12. Also a pamphlet treating of the relative values of grease and oil as lubricants. 5¼ by 8 in.; pp. 10.

Oiling and Lubricating Devices.

WM. W. NUGENT & CO., 20 W. Randolph St., Chicago—Illustrated catalogue No. 7 describes oiling and lubricating devices. Also contains a treatise on how to oil an engine. 6 by 9 in.; pp. 96.

Polishing Wheels.

SPRINGFIELD TIRE & RUBBER CO., Springfield, Ohio—Booklet containing a brief illustrated description of abrasive polishing wheels and blocks. Also numerous testimonial letters. 3½ by 6 in.; pp. 16.

Portable Heaters.

ROCKWELL FURNACE CO., 26 Cortlandt St. New York—Catalogue devoted to an illustrated description of portable heaters for heating work which is too bulky or inconvenient to remove to a furnace. 9 by 12 in.; pp. 8. Also a catalogue treating melting furnaces for melting all metals, tinning, galvanizing, tool hardening and all operations requiring molten metal or other heated baths. Illustrated. 9 by 12 in.; pp. 32.

Pumping Machinery.

DEAN BROS. STEAM PUMP WORKS, Indianapolis—Catalogue No. 71 illustrates and describes power driven pumping machinery. 6 by 7¼ in.; pp. 40.

GOULDS MFG. CO., Seneca Falls, N. Y.—Catalogue, pocket size, devoted to an illustrated description of hand and power pumps for every service. Also gives prices and sizes. 3¾ by 6 in.; pp. 8.

Recording Thermometers.

BRISTOL CO., Waterbury, Conn.—Bulletins Nos. 91 and 93 illustrate and describe thermometers for atmospheric temperature and ranges to 250 degrees Fahr. and for working ranges from 40 to 800 degrees Fahr. respectively. 8 by 10½ in.; pp. 12.

Steam Shovels.

BROWNING MFG CO., Mansfield, O.—Bulletin No. 35 treats of revolving steam shovels for locomotive crane service. Contains several views showing the shovels in operation. 6 by 9 in.; pp. 8.